# FRIENDS of HUDSON

# Response to St. Lawrence Cement's Supplemental LAER Analysis

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## 1.0 Introduction

### 1.1 Purpose of this Submission and Executive Summary

Friends of Hudson (FOH) has asked its engineering consultant, Camp, Dresser & McKee (CDM), and its attorneys Young, Sommer, Ward, Ritzenberg, Baker & Moore, LLC, to prepare this submission in response to a report submitted by St. Lawrence Cement, LLC (SLC) entitled *St. Lawrence Cement Greenport Project, SLC Hudson Valley Operation, Lowest Achievable Emission Rate Supplemental Analysis* (hereinafter "SLC Supplemental LAER Analysis"). The SLC report purports to update the lowest achievable emission rate (LAER) analysis previously prepared by SLC addressing the control of emissions of nitrogen oxides (NOx) from SLC's proposed cement plant in Greenport, New York (the "SLC project" or "Greenport project or facility"). SLC's earlier analysis concluded that a combination of multi-stage combustion (MSC) and selective non-catalytic reduction (SNCR) constitutes LAER for the facility; this determination was reflected in the draft permit prepared by the New York State Department of Environmental Conservation (DEC) and made available for public review in 2001. In the wake of recent developments in pollution control technology and information supplied to DEC by FOH, DEC requested that SLC review this determination, focusing specifically on the feasibility of using selective catalytic reduction (SCR) as an alternative to MSC and SNCR for purposes of establishing NOx LAER.

In summary, SLC's Supplemental LAER Analysis represents a continuation of SLC's past practice of providing deceiving information with respect to the state of current technological developments concerning SCR. SLC has grossly understated the NOx removal efficiency of the Solnhofen plant, claiming that the NOx reduction from SCR was only 40% when in fact the reduction was 82%. SLC submitted a package of bid specifications to various vendors that was designed to get a negative response and made no effort to work with those vendors who expressed an interest in supplying SCR to the Greenport project. In response to a more realistic bid package prepared by CDM, at least one vendor, KWH who supplied the catalyst to Solnhofen, has stated that it can supply a system to the Greenport project and can guarantee an 85% NOx removal. SLC's supposed technical analysis of problems associated with SCR is unsupported, and, more importantly, must be contrasted with SLC's preferred technology of SNCR and MSC, which it admits have never been applied together on a large scale cement plant in the United States. Finally, SLC compounds its technical misrepresentations by providing a legal analysis that does not reflect the requirements of the Clean Air Act; in addition, SLC's lawyers continue their shameless practice of citing legal authority for propositions that the cases do not support.

As set forth in greater detail below, under New York's nonattainment new source review (NSR) law, LAER is defined as "the most stringent emission limitation achieved in practice or which reasonably can be expected to occur in practice for a category of emission sources." 6 NYCRR § 200.1(ak). Although the thread of SLC's Supplemental LAER Analysis is sometimes difficult to follow, the following appear to be SLC's core arguments:

(1) The application of SCR to the Greenport cement plant is infeasible because of various insurmountable technical obstacles, including catalyst poisoning, catalyst plugging and fouling, sulfur dioxide ($SO_2$) oxidation, gas temperature issues, NOx variability and ammonia slip, undesirable byproduct formation, process start-up, shutdown and malfunction issues, and gas flow distribution concerns.

(2) The successful application of SCR at other facilities, including dozens of coal and oil-fired power plants as well as a cement manufacturing plant in Germany (the "Solnhofen facility"), is not evidence that the technology is feasible because these facilities are

"different" from the Greenport plant in ways that make successful application of SCR impossible.

(3) SLC's unsuccessful attempt to obtain a firm bid from vendors to supply an SCR system to the Greenport project shows that SCR is not commercially available.

(4) The application of SCR would not achieve NOx emission reductions greater than those achieved using MSC and SNCR, making pursuit of this "risky" control option pointless.

According to SLC, these factors, taken together, show that SCR has neither been "achieved in practice" nor can it "reasonably be expected to occur in practice" for cement kilns similar to the Greenport plant.

SLC's analysis of the technical and legal obstacles to requiring the Greenport plant to install SCR is wrong and should be rejected.

(1) **Application of SCR to the Greenport Plant is Technically Feasible.** The various technical obstacles to application of SCR identified by SLC all have been resolved at other installations, are not as critical as SLC claims, and/or are correctable with slight process modifications. Specific examples are summarized briefly below:

(a) *Catalyst poisoning.* Various coal-fired plants have successfully used SCR despite concentrations of various catalyst poisons higher than those expected at Greenport. Oil-fired boilers are operating using SCR despite the presence of water soluble flyash, suggesting that the alkali in the cement kiln flyash is unlikely to deactivate the catalyst, contrary to SLC's suggestion. *See* Section 4.2.2.1 below.

(b) *Catalyst plugging and fouling.* The Solnhofen facility operates at a dust loading of 80 $g/Nm^3$, 20 grams *higher* that the average dust loading anticipated for Greenport. The "sticky deposits" identified by SLC as a possible plugging concern appear to be unrelated to operation of the SCR system. *See* Section 4.2.2.2 below.

(c) *$SO_2$ oxidation.* The presence of high $SO_3$ concentrations has not led to catalyst deactivation and other problems at facilities with high calcium and high sulfur flue gases such as those likely to be found at Greenport (as evidenced by the experience at various coal-fired power plants and by representations from various SCR suppliers). The formation of ammonium salts can be prevented by maintaining SCR inlet temperature at an appropriate level. *See* Section 4.3 below.

(d) *Gas temperature ranges, distribution and fluctuation.* To operate effectively, the inlet temperature to the SCR must be within a certain range, with minimum fluctuations. This need can be met by installing a bypass duct around the last preheater cyclone. *See* Section 4.4 below.

(e) *NOx inlet concentrations and ammonia slip.* The reservoir of unused ammonia on the surface of the catalyst bed enables SCR systems to handle sudden peaks in inlet NOx concentrations, thereby minimizing ammonia slip. SNCR systems, by comparison, are prone to ammonia slip because they must constantly respond to changes in NOx levels by changing ammonia feed rates. Both coal-fired boilers and the Solnhofen plant have been operating successfully despite apparent NOx inlet variability. *See* Section 4.5 below.

*See* Section 4.0 for a complete analysis/rebuttal of SLC's arguments against installing SCR at the Greenport plant.

(2) **The "Differences" Between the Greenport Plant and Other Facilities Do Not Preclude the Successful Application of SCR.** SLC's argument against SCR is premised on the notion that the Greenport plant is so different from existing facilities equipped with SCR that SCR will not work. This notion is implicit in its discussion of technical feasibility in Section 4.0 of the Supplemental LAER Analysis; it also underlies SLC's argument that SCR does not constitute LAER as that term is defined in New York's nonattainment NSR regulations. In Section 5.0, SLC goes to great lengths to argue that the Solnhofen cement plant and the proposed Greenport cement plant are not in the same "source category" and that, as a result, LAER cannot be said to have been "achieved" for that source category. SLC also argues that differences between the Greenport project and both existing coal-fired boilers and the Solnhofen plant preclude successful technology transfer. The arguments in Section 5.0, although framed in legal terms, amount to nothing more than further arguments that LAER is not technically feasible for the Greenport plant. The purported "differences" identified between the Greenport plant and other facilities that are successfully operating SCR systems are not significant and/or can readily be addressed in the design and operation of the system.

(3) **SCR Systems are Commercially Available for the Greenport Project.** SLC sought bids from four SCR suppliers; two suppliers declined to bid and two suppliers submitted bids deemed "unsatisfactory" by SLC, leading SLC to conclude that SCR systems are not commercially available for the project. As discussed in Section 4.10 below, the bid specifications submitted by SLC were so stringent they virtually guaranteed that no supplier would bid successfully. The bid process also was designed to discourage suppliers from working with SLC to resolve potential technical or other obstacles to preparing a satisfactory proposal. When CDM submitted its own, more realistic bid specifications to SCR suppliers, it received one positive response; had SLC submitted a more realistic bid specification and shown a willingness to work with suppliers, its

success rate would likely have been even higher. Thus, contrary to SLC's assertions, SCR systems are commercially available for the Greenport project provided SLC is willing to work with suppliers to ensure successful design and operation.

(4) **SCR Would Achieve Higher NOx Reductions than MSC and SNCR.** SLC argues that the Solnhofen plant's SCR system is only achieving a 40% reduction in NOx emissions, a level comparable to that expected for Greenport using MSC and SNCR. As a result, they argue that there is no good reason to assume the risks associated with SCR. However, SLC has miscalculated the NOx reductions being achieved at Solnhofen; in fact, Solnhofen is achieving 82% NOx emission reductions using SCR, more than twice the level expected using MSC and SNCR. Assuming comparable rates of reduction are achieved at Greenport, the facility would emit only 1,729 tons per year of NOx using SCR (as compared to 3,718 tons with MSC and SNCR).

In light of these facts, DEC should reconsider its decision to require MSC and SNCR as LAER for the Greenport project and should instead require SLC to install SCR to ensure that the project meets the "lowest achievable emission rate." SCR has already been successfully used at one cement plant and has a long history of success on other types of facilities, including dozens of coal and oil-fired power plants. Although SLC will have to work closely with the SCR supplier to ensure that the system is designed to address the particular circumstances at the Greenport plant, there is no reason to believe that comparable NOx reductions cannot be achieved at Greenport.

### 1.2 Report Format/Outline

The SLC Supplemental LAER Analysis consists of the following five sections:

- Section 1: Outlines the steps and data collection efforts undertaken by SLC and its consultants to prepare the SLC Supplemental LAER Analysis;
- Section 2: Summarizes the background facts relating to DEC's NOx LAER determination for the Greenport project, including comments submitted by various parties, and a historical summary of SCR;
- Section 3: Provides an update of SNCR and MSC technology advancements;

- Section 4: Provides an update of SCR technology both generally and as applied to cement plants;
- Section 5: Provides a legal evaluation of SCR as NOx LAER for the Greenport project.

SLC Supplemental LAER Analysis, § 1.2, p. 1-2. To the fullest extent possible, FOH has modeled its submission after the SLC Supplemental LAER Analysis. Accordingly, FOH's submission includes the following five sections:

- Section 1: Outlines the steps and data collection efforts undertaken by FOH's consultants to review and respond to the SLC Supplemental LAER Analysis;
- Section 2: Summarizes the background facts relating to DEC's NOx LAER determination for the Greenport project;
- Section 3: Reviews and responds to SLC's update of SNCR and MSC technology advances;
- Section 4: Reviews and responds to SLC's analysis of the technical feasibility of requiring SCR as a basis for LAER at the SLC project;
- Section 5: Responds to SLC's legal evaluation of SCR as NOx LAER for the Greenport project.

FOH has formulated its response using the subject headings/subheadings in the SLC Supplemental LAER Analysis. This approach will facilitate a point-by-point comparison of the arguments made by FOH and SLC. Where FOH deviated from SLC's subject headings/organization, that fact is noted in the subject heading. To further facilitate comparison between the SLC Supplemental LAER Analysis and FOH's response, FOH has included citations to the SLC Analysis, including section and page numbers, where appropriate. It is FOH's hope that this approach will enable DEC staff to easily review and compare the arguments offered by the parties on particular issues. At the same time, however, FOH is concerned that this approach constrains its ability to properly frame its LAER analysis. FOH therefore encourages readers to review Section 5.4 below for a brief analysis of LAER outside of SLC's somewhat rigid analytical framework.

### 1.3 Data Collection Efforts

FOH's consultants, CDM, undertook the following steps in evaluating the SLC Supplemental LAER Analysis.

1. CDM thoroughly reviewed and examined SLC's Supplemental LAER Analysis including Attachments 1- 4, which together consist of over 1300 pages of background information contained on a CD-ROM.

2. CDM called the general manager at the Solnhofen plant in Germany to obtain more information about the SCR system at that plant. As discussed in Section 2.3 below, the Solnhofen plant is the first cement plant to be equipped with SCR to control NOx.

3. CDM placed initial calls to the SCR system and catalyst suppliers to which SLC sent an engineering bid specification package (hereinafter "Bid Specification") to obtain the vendors' reaction to those specifications as well as their general thoughts on the feasibility of applying SCR to the Greenport project.

4. CDM reviewed SLC's Bid Specification and compared it to an actual SCR system proposal made by a SCR supplier to a customer interested in purchasing an SCR system to determine whether SLC's Bid Specification was reasonable and appropriate in light of standard industrial practice.

5. Based on the above comparison, CDM noted significant differences between SLC's Bid Specification and what an SCR supplier typically offers in an SCR system proposal. CDM then revised SLC's Bid Specification to make it more reasonable and compatible with what would normally be contained in a typical proposal from an SCR supplier and issued the revised specification to several SCR system and catalyst suppliers to see if they could guarantee their systems based on the revised performance criteria. To date, CDM has received one positive response to this revised specification.

6. CDM also investigated SCR systems at other types of facilities, in particular, coal-fired power plants.

7. Finally, in light of the revised vendor guarantees and the operating experience of SCR systems at coal-fired power plants, CDM reevaluated the risks of SCR to the Greenport project.

### 1.4 DEC Information Request Number One: SCR at Existing Facilities

In its initial LAER analysis, SLC rejected SCR on the ground that SCR was unproven on cement plants and presented various technical problems such as catalyst poisoning and maintenance concerns. At the time the application was prepared, there were no cement plants equipped with SCR either domestically or abroad.

The current LAER reassessment process began in 2002 when CDM performed its own review of NOx LAER for cement plants and determined that a cement plant in Germany had installed and was operating an SCR system to control NOx emissions. In conjunction with that effort, CDM conducted a literature search for information concerning the German plant. Representatives of CDM also spoke with the manager of the facility, Mr. Bucher on July 29, 2002. Mr. Bucher stated that the SCR system was working very well and had been in operation for approximately 12 months. He said that before the SCR catalyst had been installed the cement kiln and preheater had been operating in a selective non-catalytic reduction (SNCR) mode and was achieving NOx emissions of 700-800 mg/m$^3$ (2.8-3.2 lbs. NOx/ton of clinker). With the SCR system, the plant had reduced NOx emissions and was meeting the German regulatory requirement of 500 mg/m$^3$ (2.0 lbs. NOx/ton of clinker while using one-tenth as much ammonia as it did when it was operating with SNCR.

After receiving information from FOH and CDM outlining the results of this research, DEC asked SLC to reassess LAER for NOx. SLC complied with the request and prepared the SLC Supplemental LAER Analysis. Upon receipt of this analysis, CDM followed up with representatives of Solnhofen to obtain updated information concerning the performance of the facility's SCR systems. In addition, CDM obtained information about ongoing operations at the facility from Solnhofen's catalyst supplier, KWH Catalysts, Inc. (KWH). On February 25, 2004 representatives from KWH met with Solnhofen plant personnel and were able to obtain valuable information about the SCR system. At this meeting, Solnhofen personnel confirmed that the SCR system has been operating for over 24,000 hours and meeting its NOx emission limits under the German regulations.

As part of its review of SCR at existing facilities, CDM also investigated other facilities which have SCR systems operating under similar (or nearly similar) conditions as those expected to be found at the proposed Greenport plant. This inquiry included the following steps.

1. CDM searched the SCR manufacturer's technical literature for information on SCR installations which would be subjected to similar operating conditions (such as dust loading, presence of catalyst poisons, high sulfur content, etc.) as those expected at the proposed Greenport plant. As discussed in Section 4.0, SCR installations at coal-fired power plants were subjected to many of the same (and in some cases more severe) operating conditions than those expected at the Greenport plant.

2. CDM compared the SCR operating conditions at coal-fired power plants and the expected operating conditions at the Greenport plant.

3. Lastly, in light of this comparison, CDM reevaluated the potential "risks" to the Greenport project.

### 1.5 DEC Information Request Number Two: Vendor Guarantees

DEC requested that SLC base its SCR analysis on SCR vendor guarantees. In response, SLC prepared an engineering bid specification package ("Bid Specification") and issued a request for proposal (RFP) to four companies with SCR application experience. According to SLC, these vendor responses "confirmed that SCR (and, thus, any resulting NOx emission rate) is not commercially available for the Greenport Project's source category." SLC Supplemental LAER Analysis, § 1.5, p. 1-4.

CDM reviewed SLC's Bid Specification and the responses submitted by the four vendors solicited. CDM also compared SLC's Bid Specification with an SCR proposal from an SCR supplier to determine whether SLC's requirements were reasonable. This review showed that SLC's bid specification package was unrealistic both in terms of the bid requirements and the penalties imposed for failing to meet vendor guarantees. The unrealistic nature of the specifications and penalties virtually assured that no vendor would be willing to bid to provide SCR technology to the Greenport project. CDM found the following problems with SLC's approach to the bidding process.

1. SLC demanded very stringent performance requirements. Notable among these were the 90% NOx reduction efficiency and the 0.5 mole % sulfur dioxide ($SO_2$) oxidation limit.

2. There were no conditions or limitations put on the performance requirements. Typically a vendor's performance requirements are guaranteed for a well-defined range of operating conditions (such as flue gas flow rate, temperature, composition, fuel use, fuel characteristics, process feed characteristics, etc.). SLC's Bid Specification, by comparison, required the NOx reduction, ammonia slip, $SO_2$ and gas side pressure loss criteria to be met "at any time under any operating condition". This requirement is unrealistic. No vendor would make a commercial offer under these conditions. Vendor guarantees typically require that the plant be properly operating at stable continuous conditions and that the SCR system be operated and maintained in accordance with the catalyst supplier's Operations and Maintenance Manual. The SLC Bid Specification does not contain any of these typical conditions of guarantee.

3. SLC's Bid Specification did not allow for flexibility to address areas of concern. For instance, the Bid Specification called for SCR inlet temperatures of 320°C. To the extent temperatures at the Greenport plant might be slightly lower, this potential problem could likely be solved by installing a bypass duct around the last preheater cyclone as discussed in Section 4.4.2. However, SLC left no room for consideration of such a technique even though bypass ducts are commonly used on economizers on power plants.

In addition, SLC's bid specifications for the vendor guarantees are inconsistent with the guarantees SLC obtained from Krupp Polysius for the SNCR system. In comparison with the rigorous Bid Specification prepared by SLC, the SNCR guarantee from Krupp Polysius is deficient in the following areas: (1) there is no guarantee offered on $NH_3$ slip; (2) there is no turndown capability of the system specified. By comparison, the SCR Bid Specification required that the SCR system operate over a temperature range at the inlet to the reactor of 300°C to 400°C and over a flow rate range between 600,000 $m^3/hr$ to 950,000 $m^3/hr$.; and (3) the Krupp Polysius offer contains no information regarding overall system availability. By comparison, the SCR Bid Specification required the system to be available at least 98% of the time the kiln is in operation. In addition, Krupp Polysius did not provide support data and documentation from other cement kilns using MSC and SNCR to confirm that their SNCR system could, in fact, achieve the NOx emission level indicated. The guarantees obtained from SLC's SNCR provider thus were much less stringent than those demanded of the SCR suppliers.

Concerned that SLC's unrealistic Bid Specification would prevent meaningful review of SCR, CDM prepared its own revised bid specification using an actual SCR system proposal submitted by an SCR supplier as a model. Copies of these revised Bid Specifications are included as Attachment A. This exercise yielded one positive response from an SCR supplier, in the form of a letter specifying that the company could meet the revised, and more realistic, bid specification, with certain minor exceptions. Copies of the responses to CDM's revised Bid Specifications received to date are included as Attachment B. *See* Section 4.10 for a discussion of vendor proposals.

### 1.6 DEC Information Request Number Three: SNCR and MSC

*See* Section 3.0 below.

### 1.7 DEC Information Requests Summary

From the outset of the project review process, FOH and its consultant CDM have invested considerable time and resources in assessing the air pollution control strategies proposed by SLC to address emissions from the Greenport project. In light of the significant NOx emissions associated with the project, much of these resources have been devoted to assessing SLC's NOx control strategy. FOH and CDM researched the MSC/SNCR combination proposed by SLC as NOx LAER and identified SCR as a technically feasible and more effective control strategy. In the wake of the SLC Supplemental LAER Analysis, CDM has conducted further research on the experience at both the Solnhofen facility and at coal and oil-fired power plants to better understand the benefits of, and possible obstacles to, using SCR at Greenport. CDM also reached out to SCR vendors both by telephone and in writing to assess the commercial viability of SCR at Greenport. These efforts have revealed that SCR is a technically viable and effective means of reducing NOx emissions from the Greenport cement plant.

**2.0 Background** [NOTE: This section does not correspond to a section in SLC's Supplemental LAER Analysis.]

**2.1 SLC's Initial NOx LAER Determination**

SLC is proposing to construct a cement production facility in Greenport, New York that will produce approximately 2,600,000 tons of clinker each year. The facility will emit, without controls, more than 5,460 tons per year (tpy) of NOx, a pollutant which contributes to the formation of both ozone and acid rain. To reduce emissions of NOx, SLC is proposing to use a combination of multi-stage combustion (MSC) and selective non-catalytic reduction (SNCR). MSC is a combustion control technique in which fuel and air are added to the process to create separate combustion zones in the kiln and precalciner. A fuel rich, reducing zone (zero $O_2$ level) is formed in the lower section of the precalciner which prevents NOx formation and converts some NOx to $N_2$. However, the lack of oxygen in this zone promotes the generation of CO and products of incomplete combustion. Above this zone in the precalciner, air is added to complete the combustion of CO and products of incomplete combustion. Overall combustion of the fuel is accomplished at lower temperatures than if the fuel were fired in the kiln burner and hence NOx generation is reduced. SNCR is an add-on control technology which involves the injection of ammonia ($NH_3$), ammonia water or urea into the precalciner flue gas. The injected ammonia is first converted by OH radicals in the flue gas to $NH_2$. The $NH_2$ then reacts with the NOx in the flue gas to form $N_2$, $CO_2$ and water. The SNCR reaction can only proceed in the temperature band between 1600° F and 1900° F. Also, SNCR requires an oxidizing or fuel-lean atmosphere to reduce the NOx. Lastly, CO or other reactants compete with the ammonia for the OH radicals and thereby suppress NOx reduction. Thus, for MSC and SNCR to simultaneously occur in the precalciner the ammonia injection and deNOx reaction must occur in the upper portion of the precalciner where the there is sufficient oxygen and negligible CO. There must be careful control of fuel and air in the precalciner to allow MSC and SNCR to simultaneously proceed in the same vessel.

According to SLC, these technologies together will achieve NOx emissions reductions of approximately 40% from the preheater exhaust gas, excluding the alkali sulfur reduction system (ASRS). This translates to emissions of approximately 3,718 tpy of NOx (or 2.8 lbs. NOx/ton of clinker). This rate will be achieved at the end of a three-year MSC/SNCR demonstration period beginning with the initial start up of the cement kiln.

In developing its draft permit for the proposed facility, DEC set NOx emission limits for the SLC facility based on the assumption that the facility would be equipped with MSC plus SNCR. Under the draft permit, SLC is limited during the first two years of operation to 4,121 tpy of NOx emissions (or 3.6 lbs. NOx/ton of clinker) which corresponds to a 20% NOx reduction from the preheater exhaust gas (excluding the ASRS). The permit calls for this rate to decrease over a one-year period at the end of which the permit would limit emissions to 3,718 tpy of NOx (2.8 lbs. NOx/ton of clinker) subject to possible further downward revision by DEC.

According to SLC, the emission rates contained in the draft permit issued by DEC satisfy the lowest achievable emission rate (LAER) requirements of New York's nonattainment NSR program. In its Petition for Party Status, Friends of Hudson questioned this determination. FOH argued, among other things, that the three-year period for phasing in NOx reductions did not satisfy LAER. Following the issues conference, the Administrative Law Judges (ALJs) identified several aspects of SLC's NOx control strategy as issues for adjudication in their December 7, 2001 decision (hereinafter "ALJs' Initial Ruling"). In particular, the ALJ's concluded with respect to NOx that "The adequacy of SLC's NOx LAER analysis is an appropriate subject for an adjudicatory hearing because there is reasonable doubt as to whether the phase-in is necessary, whether the emission limits set by staff in the draft permit are sufficiently stringent and why SNCR is not proposed for the alkali bypass." ALJs' Initial Ruling, p. 26. SLC appealed this and other decisions made by the ALJs to the Commissioner. To date, no final decision by the Commissioner on the adjudicability of NOx LAER has been issued.

### 2.2 SLC's Initial Rejection of SCR as LAER

SCR systems use catalysts to chemically convert nitrogen oxides to molecular nitrogen. Ammonia ($NH_3$) is injected in the gas stream upstream of the catalyst. The $NH_3$ reacts with NOx on the surface of the catalyst to produce molecular nitrogen and water vapor. SCR technology is now commonly used to reduce NOx emissions from coal and oil-fired power plants and is an increasingly popular NOx control alternative in other industrial applications. Although the levels of NOx emission reduction achieved using SCR vary among industrial applications, SCR typically achieves greater NOx reductions than SNCR.

At the time it submitted its initial air permit application and LAER analysis, SLC rejected SCR on the ground that "SCR has never been tested on a cement kiln in the U.S. and has only been tested for very short periods on pilot plant size exhaust gas streams. SCR controls of NOx emissions from a cement kiln is unproven on full-scale facilities and for normal operating periods, and has substantial technical obstacles, which limit its application." April 27, 2001 Air Permit Application, p. 6-22. SLC went on to identify catalyst poisoning and maintenance concerns as major obstacles to implementation of SCR. At the time the application was prepared, there were no cement plants equipped with SCR in full-scale operation either domestically or abroad.

### 2.3 Subsequent NOx LAER Submissions, Including DEC's Request for NOx LAER Update

As noted above, even with the MSC and SNCR proposed by SLC as NOx LAER, the draft permit will authorize the Greenport facility to emit 3,718 tpy of NOx once these systems have been optimized. Concerned about these high emission levels, FOH asked CDM to conduct additional research concerning alternative strategies for reducing emissions of NOx from the proposed SLC plant, with a focus on SCR. In the course of that research, CDM determined that a cement plant in Germany operated by Solnhofen Portland-Zementwerke AG (hereinafter the "Solnhofen plant") had installed and was successfully operating an SCR system to control NOx emissions. At FOH's request, CDM prepared a report summarizing the results of their research concerning the recent developments in SCR both generally and with respect to the Solnhofen plant. FOH forwarded that report to DEC by letter dated February 4, 2003, and requested that DEC reconsider its determination to approve MSC plus SNCR as NOx LAER for the proposed Greenport plant.

SLC responded to FOH's submission in a letter from its attorneys dated February 19, 2003. The letter reiterated its support for its initial LAER determination and attempted to identify flaws in both the technical and legal underpinnings of FOH's request for redetermination. FOH replied to the SLC submission by letter dated February 4, 2003. That letter identified several major legal flaws in SLC's LAER analysis (flaws that have been repeated in the SLC Supplemental LAER Analysis) and reiterated FOH's request for redetermination. The Massachusetts Department of Environmental Protection (MADEP) also submitted a letter supporting consideration of SCR as LAER and offered both legal and technical responses to the issues raised by SLC.

Several months after receiving FOH's SCR submission and request for redetermination, DEC asked SLC to update its NOx LAER analysis to reflect the most recent information available on NOx emission control technology for portland cement plants. In particular, DEC asked that SLC include a detailed evaluation of SCR and its use at the Solnhofen plant in Germany, together with an evaluation of the latest advancements in use of the combination of SNCR and MSC. The letter included a specific list of 14 questions SLC was expected to answer in preparing its response.

### 2.4 SLC's Supplemental LAER Analysis

Five months after receiving DEC's LAER update request, SLC submitted its Supplemental LAER Analysis to DEC. The December 2003 report purportedly "demonstrates that NYSDEC properly determined that NOx LAER for the Greenport Project is an emissions rate, based on the application of SNCR and MSC technology" and that "the use of SCR has not been achieved in practice at the Greenport Project's source category nor could a successful application of SCR be expected to occur at the Greenport project." SLC Supplemental LAER Analysis, Executive Summary, pp. E-1 to E-2. As discussed in the remainder of this submission, this conclusion is based on faulty technical and legal analysis and must be rejected.

## 3.0 Technical Review of SNCR and MSC Technology

These comments do not include a complete evaluation of SNCR and MSC technology because of the obvious benefits of SCR, which will achieve at least twice the NOx reduction efficiency of SNCR and MSC. However, there are some discrepancies in SLC's SNCR and MSC presentation which must be noted.

The most obvious discrepancy lies with SLC's characterization of SNCR and MSC as compared to SCR. While SLC regularly denigrates SCR as unproven and unreliable, it praises SNCR and MSC as innovative. This presents a curious disconnect regarding SLC's views of the two technologies. SLC states:

> [T]he Greenport Project will be the first cement manufacturing plant in the United States to install a full-scale application of SNCR, and the second facility in the world to utilize MSC in combination with SNCR on a regular basis. No cement facility in the world has ever attempted to install and operate the combination of these control technologies while simultaneously complying with stringent opacity and carbon monoxide limitations. SLC Supplemental LAER Analysis, § 3.1, p. 3-1.

Given SLC's reluctance to consider SCR due to its limited use in the cement industry it is very curious that it does not have same concerns for the untested combination of SNCR and MSC. SLC continues to point to the innovative and experimental nature of the SNCR/MSC combination by demanding the two-year testing program before a final NOx limit is set and recognizing the operational difficulties of injecting ammonia into the SNCR system in the proper amounts given fluctuations in the flue gas characteristics. In contrast, the experience with SCR in power plants is well established and does not involve the operational sensitivity associated with SNCR. Recent adaptations of SCR to cement plants have demonstrated that key issues have been resolved and that SCR is far less innovative and experimental than SNCR/MSC and will provide dramatically greater levels of NOx emission reductions.

Another discrepancy involves SLC's use of data from the Lagerdorf Kiln 11 in Lagerdorf, Germany. These data show annual average NOx emissions of less than 500 mg/Nm$^3$ (2.0 lbs./ton of clinker) for the years 2000, 2001 and 2002. SLC then states that these low NOx emission limits should not be imposed on the Greenport project because "the Lagerdorf kiln 11 does not operate with stringent opacity and CO limitations as part of its European operating permits." It should be noted, however, that the Solnhofen plant in Germany operates under a daily average CO limit of 50 mg/ Nm$^3$ which raises questions about whether the Lagerdorf Kiln also is subject to a CO limit.

Moreover, SLC overstates the stringency of the proposed CO limits. SLC's draft permit contains a CO limit for the Greenport plant of 3.0 lbs./ton of clinker, equivalent to 1050 mg/Nm$^3$. This limit is more than 20 times greater than the CO limit at Solnhofen. Note also that the Solnhofen plant in 2001 achieved an annual average NOx concentration of 616 mg/Nm$^3$ (2.8 lbs./ton of clinker) using SNCR for most of the year (7 months) and still met its average daily CO requirement of 50 mg/Nm$^3$. These facts together suggest that the Greenport plant is not being held to a stringent CO requirement, contrary to SLC's assertions. In fact, based on the Solnhofen air permit, the Greenport plant has a relatively lax CO requirement. That low limit should not be used to justify a low NOx removal efficiency using SNCR.

It should also be noted that the combination of SNCR and MSC proposed by SLC as LAER is much more prone to $NH_3$ slip than SCR. This is due to the inherent complexity of carrying out competing reactions in the same vessel (the precalciner) and the necessity of simultaneously controlling fuel, air and ammonia flow rates to establish different zones in the precalciner, specifically: a reducing, zero % oxygen, 1% CO condition in the lower portion of the precalciner and an oxidizing, 2-3% oxygen, zero % CO condition in the upper portion of the precalciner. In addition, these conditions have to be maintained while the NOx concentration is fluctuating widely. This process is more difficult to control than an SCR reactor and is likely to result in much higher $NH_3$ slip levels. As noted in Section 4.5, it is not surprising that at least one Canadian cement plant with SNCR is investigating SCR as a means of eliminating its $NH_3$ slip problem.

## 4.0 Technical Evaluation of SCR as NOx LAER for the Greenport Project

SLC raises various technical issues regarding the application of SCR control technology to the Greenport project. SLC claims that because of these issues the use of SCR control at the Greenport plant is "neither a commercially available nor a technically feasible control system". SLC Supplemental LAER Analysis, Executive Summary, p. E-3. These issues include: (1) catalyst poisoning; (2) catalyst plugging and fouling; (3) catalyst composition, NOx reduction and $SO_2$ oxidation; (4) gas temperature issues; (5) NOx variability and ammonia ($NH_3$) slip; (6) undesirable byproduct formation; (7) process start-up, shut down, and malfunction; and (8) gas flow distribution. As discussed in greater detail below, however, virtually all of these issues:

(1) have been addressed and resolved at SCR installations;

(2) are not as critical a concern as SLC claims; and/or

(3) are correctable by slight modification to the cement-manufacturing equipment.

While data from the Solnhofen plant has been difficult to obtain, we do know that the SCR system at Solnhofen has been operating for over 24,000 hours and is meeting the German regulatory limit of 500 mg/Nm$^3$ of NOx. *See* KWH Letter, dated February 27, 2004 included in Attachment B. The plant manager, Mr. Gerd Sauter, states that the inlet NOx to the SCR system is 2500 mg/Nm$^3$. Thus, the SCR has been achieving greater than 80% NOx removal ((2500-500)/2500) for a prolonged period of time – over 24,000 hours. The potential "risks" cited by SLC (i.e., poisoning, surface plugging and fouling, pore masking from formation of calcium sulfate or ammonium salts, etc.) have not been a problem, nor have NOx inlet variability and $NH_3$ slip.

Moreover, many of the issues raised by SLC have been addressed at SCR installations on dozens of coal and oil-fired power plants, many of which have been operating successfully for several years. The table at Attachment C compares the flue gas characteristics and composition of three coal-fired power plants to the flue gas of SLC's proposed cement plant. The flue gas design parameters for the Greenport plant are taken from SLC's Bid Specification and are presumably SLC's best estimate of the flue gas composition at the outlet of the preheater tower, directly upstream of where an SCR system would most likely be located. The data from the three coal-fired power plants is based on plant design parameters (gas flow rate, dust loading, etc.) and chemical analyses of the particular coal being burned. The data from the Kansas City P&L plant, which burns Powder River Basin (PRB) coal, is most interesting because of the high dust loading and the high calcium content of its flyash. The operating experience of these three power plant SCR systems is briefly summarized at the bottom of the table. That information shows that all three power plants have achieved their SCR design parameters to date.

### 4.1 Overview – SCR System Operating Principles

*See* discussion of SCR System Operating Principles in SLC's Supplemental LAER Analysis.

### 4.2 Catalyst Deactivation

#### 4.2.1 Catalyst Deactivation - Background/Summary

The health of the catalyst is key to successful operation of an SCR system. As SLC correctly notes, when an SCR catalyst is damaged either chemically or physically, its ability to convert NOx and $NH_3$ to $N_2$ is reduced. According to SLC, "[c]atalyst deactivation is one of the most serious issues that must be faced in applying SCR to any new source category." SLC Supplemental LAER Analysis, § 4.2, p. 4-6. After purportedly reviewing available data, SLC concluded that potential catalyst deactivation presents "serious risks" for the Greenport project and that, as a result, SCR is not technically feasible. *Id.*

### 4.2.2 Catalyst Deactivation - Risks for the Greenport Project

SLC's Supplemental LAER Analysis significantly overstates the risk of catalyst deactivation. The data from coal-fired power plants show that catalyst poisons are present in coal-fired SCR systems, sometimes at concentrations greater than those anticipated at the Greenport plant; these poisons have not prevented the SCR systems from achieving their performance guarantees. SLC also argues that the alkali poisons from coal-fired power plants are not water soluble and hence not available to deactivate the SCR catalysts installed at coal-fired power plants. However, a review of coal-fired flyash properties shows that some flyash from coal-fired boilers *is* water-soluble; under SLC's theory, this flyash would be available to deactivate the SCR catalyst. No such deactivation has, however, occurred. In fact, SCR systems have been installed and successfully operated at oil-fired boilers where a majority of the flyash is water soluble. This evidence suggests that the presence of water-soluble alkali is not an adequate or sufficient reason for claiming that SCR is technically unfeasible on a cement kiln.

#### 4.2.2.1 Poisoning

Catalyst poisoning occurs when the contaminants in the gas being treated react with the catalyst, resulting in catalyst deactivation. SLC claims that the SCR catalyst in a cement plant will be subject to poisoning, principally from sodium (Na), potassium (K), and arsenic trioxide

($As_2O_3$). Phosphorous, chromium and lead compounds can also poison an SCR catalyst, but since these are expected to be present in lower concentrations at the Greenport plant, they are of lesser concern. SLC identifies two factors that may affect the impact of catalyst poisons on an SCR system, namely: (1) the total quantity of poisons entering the system and (2) the availability of the catalyst poisons in the gas stream reaching the vanadium pentoxide ($V_2O_5$) in the SCR catalyst.

On the issue of the total quantity of poisons entering the SCR system, the data in the table at Attachment C show that the typical concentration of sodium oxide ($Na_2O$) in the particulate matter (PM) of the Kansas City coal-fired plant is more than double the expected concentration of $Na_2O$ in the PM of the Greenport plant, and the maximum concentration of $Na_2O$ is approximately 3.5 times the maximum expected concentration of $Na_2O$ in the PM of the Greenport plant. Similarly, the concentration of $As_2O_3$ in the flue gas of the Somerset plant is 2.3 to 2.5 times the concentration of $As_2O_3$ in the expected flue gas from the Greenport plant. If the above catalyst poisons were an insurmountable barrier to the use of an SCR system as claimed by SLC, then the SCR systems at the Kansas City and Somerset plants could not possibly have operated successfully (meeting their NOx removal efficiencies, catalyst life and other design criteria) for over 2.5 and 4.5 years, respectively. This experience shows that catalyst suppliers can and do design effective and reliable catalysts and SCR systems that account for these poisons.

Regarding the availability of catalyst poisons, SLC presents two interconnected arguments on pages 4-16 through 4-19 of the SLC Supplemental LAER Analysis. The arguments deal with the solubility of Na and K in the flyash and the form of the flyash particles, which SLC identifies as "glass-like". According to SLC,

> In cement preheater-precalciner kilns, materials such as sodium and potassium compounds may be present in relatively elevated concentrations on the surfaces of particles in "water soluble" form (*see* Section 4.2.2.1) that can contact the surface of the SCR catalyst bed and thereby provide an opportunity to poison the $V_2O_5$ "active ingredient" in the SCR bed. Conversely, in coal-fired boilers, the sodium and potassium are, to a major extent, trapped within a glass-like flyash particle.

SLC Supplemental LAER Analysis, § 4.2.2.1, p. 4-16 (citation omitted). SLC then shows two electron micrographs: one showing dust from a cement kiln and the other flyash from a coal-fired boiler. The flyash from the coal-fired boiler appear round or spherical which SLC labels as "Examples of glass-like particles". SLC goes on to state,

> Contact between a glass-like flyash particle and an SCR catalyst has only minimal opportunity to poison the $V_2O_5$. In contrast, catalyst deactivation due to sodium and potassium in certain cement kiln applications due to the surface "availability" of these compounds could result in rapid catalyst deactivation that, in turn, reduces the NOx control efficiency that can be attained by an SCR system. *Id.* at 4-18.

Lastly, SLC states, "It is generally accepted that most coal-fired boilers do not have high 'water soluble' alkali." *Id.*

SLC's analysis contains several flaws. As a preliminary matter, SLC assumes that the round flyash from coal-fired boilers are "glass-like" and can trap Na and K. This assumption is simplistic and misleading. It is widely known that flyash particles from coal-fired boilers are "in the form of tiny spheres (cenospheres)" and that "during the combustion of the coal, the particles were actually liquid and the spheres were formed as tiny bubbles by evolved gases trying to escape". Steam/Its Generation and Use, 39th Edition, The Babcock & Wilcox Company, New York, NY, 1978, p. 15-3. Boilers are designed to cool the molten particles to a solid state (i.e., a dusty ash) such that they can be easily removed from boiler tubes. However, depending on the temperature of the flyash and its chemical composition, some of the flyash will deposit in various sections of the boiler. The deposits that form at the back-end of the boiler (on the economizer and air heater) are called "low-temperature deposits". Low temperature deposits "are usually characterized by low pH (highly acidic); many contain hydrated salts, and for most bituminous coals are water soluble." Id. at 15-14. Therefore, coal-fired boilers do have flyash deposits in the economizer section of the boiler (where an SCR system would be located) which are water soluble. Under SLC's theory, the alkali in the flyash would be available to deactivate an SCR catalyst. In fact, however, deactivation does not occur.

Moreover, SCR systems have been installed on oil-fired boilers despite the relatively higher levels of water-soluble alkaline metals found in the flyash from such boilers. In their reference lists (supplied as part of the vendor responses to SLC's Bid Specification), KWH lists seven SCR systems on oil-fired boilers, and Alstom Power (Alstom) lists six SCR systems on oil-fired boilers. These facts together show that the problem of water-soluble alkali has been addressed by catalyst suppliers.

In conclusion, SLC has overstated the potential risks of catalyst poisoning. First, catalyst poisons are present in coal-fired SCR systems sometimes at concentrations greater than those anticipated at the Greenport plant, and these poisons have not prevented the SCR systems from achieving their performance guarantees. Second, SLC incorrectly claims that the flyash from coal-fired power plants is not water soluble and hence is unavailable to deactivate an SCR catalyst. In fact, however, some flyash from coal-fired boilers *is* water-soluble. The presence of this water soluble flyash has not prevented successful operation of SCR at coal-fired boilers. Finally, SCR systems have been successfully applied to oil-fired boilers where a majority of the flyash is water-soluble. Thus, the possible presence of water-soluble flyash will not render SCR technically infeasible for a cement kiln.

### 4.2.2.2 SCR Catalyst Plugging and Fouling

Catalyst plugging and fouling involves the accumulation of dust that blocks access to the pores of the catalyst. SLC maintains that the dust loading to an SCR system at the Greenport plant would be approximately 60 grams per normal cubic meter ($g/Nm^3$) on average and 100 $g/Nm^3$ at maximum conditions and that these high dust loadings could plug or foul the SCR catalyst beds. As a preliminary matter, SLC acknowledges that the Solnhofen SCR system has operated at a dust loading of 80 $g/Nm^3$, 20 grams *higher* than the average dust loading anticipated for Greenport. However, SLC dismisses this fact by noting that the Solnhofen plant purportedly has been achieving only 40% NOx control. As discussed in Section 4.8A below, this estimate is wrong. The Solnhofen plant is, in fact, achieving approximately 82% NOx control. This level of success shows that high dust loading can be managed to avoid catalyst plugging and fouling while maintaining high levels of control.

Related to the plugging and fouling issues, SLC presents a theory that "sticky deposits" in the preheater exhaust gas could foul and plug the SCR catalyst. Specifically, SLC states that "certain cement kiln operations have shown to be prone to producing sticky deposits at exactly the temperature ranges in which SCR systems operate." SLC Supplemental LAER Analysis, § 4.2.2.2, pp. 4-21 to -22. To support this statement, SLC references two articles, one by Gutzwiller et al. and the other by Berube. Gutzwiller, L., et al. Undated. Cement Plant Preheater Fan Buildup Control. Robinson Industries, Inc.; Berube, R. A. 1996. Effective Temperature Control for Cement Kiln Off-Gases. TurboSonic, Inc. Waterloo, Ontario. March,

1996. A careful reading of the article by Gutzwiller reveals that "sticky deposits" are a widespread problem occurring throughout the world on cement kiln induced draft (I.D.) fans. According to that article, "Typically, in many plants it is an extremely hard, layered, brick-like build-up that is associated with impingement of particulate at high velocity against the rotating parts of the fan impeller." Gutzwiller, p. 1. The article investigates various thermal, chemical, electrostatic and mechanical causes of the build-up and concludes that, "[t]he build-up problem is definitely temperature and impact velocity related." Gutzwiller, p. 6.

While the presence of alkali in the cement kiln system is a factor in the build-up, the mechanical aspect (namely, impact velocity) is more critical to the formation of build-up. The author's recommendation for avoiding build-up is to select a fan which minimizes the gas/dust velocity at the inlet of the fan rotor. Alternatives proposed by the author include using double inlet fans or using larger diameter, lower RPM (revolutions per minute) fans. The article does not mention sticky deposits or build-up developing on other parts of the cement kiln system. Thus, the "sticky deposits" problem appears to be related solely to the I.D. fan and is due to the high impact velocity of the dust particles on the fan. This problem should not affect an SCR catalyst which is subject to comparatively low gas velocities in comparison to an I.D. fan. For instance, gas velocities through an SCR system are typically less than 6.2 meters per second (1220 ft./min.),[1] whereas peripheral gas speed at the kiln I.D. fan rotor inlet is approximately 15,000 ft./min.

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1 Pritchard, S.G., et al. Optimizing Catalyst Design and Performance for Coal-Fired Boilers EPA/EPRI Joint Symposium on Stationary Combustion NOx Control. CORMETECH, Inc., Durham, N.C. May 1995. p. 15.

Possible problems relating to thermal sintering[2] and catalyst erosion[3] have been addressed by advances in catalyst technology and proper system design.

### 4.3 Catalyst Composition, NOx Reduction Efficiency and $SO_2$ Oxidation

Catalyst composition, NOx reduction efficiency and $SO_2$ oxidation are interrelated factors and therefore will be jointly considered. In their Supplemental LAER Analysis, SLC attempts to show that SCR systems on coal-fired power plants are rarely achieving their target NOx reduction efficiencies and/or 90% NOx reduction. SLC presents data from a 1997 EPA study on SCR systems installed on coal-fired power plants in the United States and Europe. These data are summarized in Figure 4-11 of SLC's Supplemental LAER Analysis which shows five NOx reduction efficiency ranges and the number of SCR units achieving NOx reductions in each efficiency range. The data are reproduced below:

| Number of SCR Units | $NO_X$ Reduction Efficiency |
|---|---|
| 2 | Less than 60% |
| 9 | 60% to 70% |
| 6 | 70% to 80% |
| 11 | 80% to 90% |
| 2 | Greater than 90% |

Of the 30 SCR units for which data are presented, the average inlet NOx emission level is 0.67 pounds per million Btu of fuel fired (lbs./MMBtu), and the average outlet NOx level is 0.14

[2] As noted by SLC, the problem of thermal sintering has been avoided by the incorporation of tungsten in the catalyst formulation and also by providing a bypass around the SCR system so that the catalyst is not exposed to high temperature excursions.

[3] Catalyst erosion has been addressed by hardening the leading edge of the catalyst and also arranging the catalyst bed so that the air flow is parallel to the catalyst channels. As stated by Prichard et al. "Experience has proven that no significant erosion will occur with proper system design, catalyst material durability and catalyst edge hardening." Pritchard, S.G., et al., p. 15.

lbs./MMBtu which yields an average NOx reduction efficiency of 79% ((0.67-0.14)/0.67). The study states the following:

> The findings indicate that all coal-fired units using SCR have achieved targeted NOx emission levels. Many units reported average NOx emission levels at or below 0.15 lbs/MMBtu. Those units reporting emission levels higher than 0.15 lbs/MMBtu are generally meeting emission limits set at these higher levels. In general, operational histories of SCR installations indicate that NOx reductions are being achieved in a reliable manner.

EPA Acid Rain Program, "Performance of Selective Catalytic Reduction on Coal-Fired Steam Generating Units", Interim Report, 1997, p. 2. Thus, the reason that many of the units are not achieving NOx removals greater than 80% is that the plants were not designed to achieve such high removal efficiencies. Even at an average of 79%, the SCR systems at these plants are achieving NOx reductions far greater than the 40% SLC estimates achieving using MSC and SNCR.

More important, SLC's discussion ignores the great advances in the application of SCR technology which have taken place since the EPA report was published in 1997. Recent third quarter 2003 data from the McIlvain Company show that 19 coal-fired power plants in the United States are achieving NOx emission levels of 0.06 lbs./MMBtu or less.[4] A copy of this information is included as Attachment D. Using the average uncontrolled NOx level in the EPA study (0.67 lbs./MMBtu), the NOx reduction efficiency for the 19 plants is 91% ((0.67-0.06)/0.67). Thus, present day SCR systems are typically achieving NOx reduction efficiencies of 90% or greater.

4 *See* McIlvaine Company, *FGD and DeNOx Newsletter*, January 2004 which can be obtained from the following web site: http://www.mcilvainecompany.com/newsletters. The McIlvain Company compiles data on industrial facilities (principally steam and power production plants and their air pollution control equipment) and makes this database available to customers who subscribe to their service.

In this section of the report SLC again states that the Solnhofen plant is achieving only modest NOx reductions of approximately 40%. SLC then states that when only a low NOx reduction is required, the catalyst manufacturer can use a catalyst with a lower vanadium oxide content which will reduce the oxidation of $SO_2$ to $SO_3$ and thereby avoid the potential for $CaSO_4$ masking. As pointed out in Section 4.2.2.1, however, the Solnhofen SCR system is achieving a high degree of NOx control. SLC's statements regarding catalyst formulation thus do not accurately reflect conditions at the Solnhofen plant; they also do not support SLC's argument that the catalyst masking will increase as levels of control increase.

SLC also argues strenuously that high $SO_3$ concentrations could lead to catalyst deactivation and other serious problems relating to $SO_2$ oxidation. According to SLC, the Greenport project will have a $SO_2$ concentration of 1700 mg/Nm$^3$ (600 ppmv) in the preheater exhaust gas. With 0.5% to 2.0% $SO_2$ oxidation, a high $SO_3$ concentration of 8 to 17 ppmv could result. This high $SO_3$ concentration, when coupled with the high calcium level in the cement kiln flue gas, could purportedly cause deactivation of the SCR catalyst due to the masking effect of calcium sulfate ($CaSO_4$). SLC Supplemental LAER Analysis, § 4.3.1.4, p. 4-30. SLC then goes on to argue that any $SO_3$ that does not react with the calcium could react with any unused $NH_3$ to form ammonium sulfate (AS) or ammonium bisulfate (ABS) which could cause fouling of downstream equipment. To make this point, SLC contrasts $SO_2$ levels at Greenport and Solnhofen. In particular, SLC states that "Solnhofen has not had to face $SO_3$ concentrations of this magnitude because the inlet $SO_2$ concentrations are apparently quite low (i.e. less than 1% of the $SO_2$ levels anticipated at the Greenport Project)." SLC Supplemental LAER Analysis, § 4.3, p. 4-31. In a footnote SLC states that the inlet $SO_2$ concentration at Solnhofen is assumed to be 15 mg/Nm$^3$ or less based on data from a November 2001 test which reported a daily average $SO_2$

concentration of 6 $mg/Nm^3$ over a two-day period. SLC then concludes that Solnhofen does not have to deal with the potential problem of $SO_2$ oxidation and the masking effect of $CaSO_4$ due to due to this low $SO_2$ concentration.

SLC's argument is faulty for several reasons. First, the comparison with Solnhofen is incorrect. The 6 $mg/Nm^3$ concentration is a stack concentration. At Solnhofen there are three processes following the preheater tower which reduce $SO_2$ emissions. First, there is the SCR reactor itself which Haug et al. report reduces $SO_2$ emissions by 50% to 70%.[5] Second, the Solnhofen plant has an evaporative cooler upstream of a fabric filter (or baghouse). The purpose of the evaporative cooler is to condition and cool the flue gas to less than 125° C so that the downstream fabric filter can collect not only particulate matter but also $SO_2$ and other acid gases.[6] The combination of the preheater exhaust gas with a high loading of calcium oxide, the evaporative cooler, and the fabric filter essentially constitutes a spray dry adsorber or dry scrubber. In its Air Permit Application SLC states that a dry scrubber can achieve $SO_2$ removals of 85% to 90%. Third, prior to the fabric filter, the Solnhofen plant has a raw mill which dries the raw feed to the plant. Estimates of up to 50% $SO_2$ reduction have been attributed to the scrubbing action of the raw mill. Using the above maximum $SO_2$ removals, the $SO_2$ concentration at the inlet to the SCR reactor at Solnhofen could be as high as 400 $mg/Nm^3$ (6 $mg/Nm^3$ x 1/(0.3 x0.1x0.5)). Furthermore, if the half-hour average $SO_2$ concentration of 11 $mg/Nm^3$ is used, the calculated $SO_2$ concentration at the SCR inlet could be as high as 733

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5 Haug, S. and G. Samant. Einsatz der High-Dust-SCR-Technologie in der Zementindustie, BAT – und preisorientierte Dioxin-/Rauchgasreinigun gstechniken 2002 fur Verbrennungs-und Feurungsan lagen, Sept. 2002, p. 4.

6 *See* diagram of Solnhofen plant containing evaporative cooler and design data on fabric filter contained in Attachment E.

mg/Nm$^3$. Although this estimated concentration is still below the 1700 mg/Nm$^3$ SLC estimates for the Greenport plant, it is well above the 6 mg/Nm$^3$ estimated by SLC for Solnhofen.

Moreover, there is some question as to how SLC arrived at its 1700 mg/Nm$^3$ estimate. In the Air Permit Application, SLC starts with a high sulfur content in the raw mix of 0.73% and assumes there will be 70% "inherent scrubbing" of $SO_2$ by the raw mix in the preheater tower. Using these two factors and the Greenport plant production (2.6 x10$^6$ tons/yr of clinker), SLC calculates 7,370 tons of $SO_2$ per year will be released from the preheater tower. This quantity of $SO_2$ corresponds to an $SO_2$ concentration of approximately 1980 mg/Nm$^3$ or 700 ppmv which is about the maximum $SO_2$ concentration estimated by SLC. This analysis presents several problems. First, SLC does not present any data to validate the relatively high sulfur content (0.73%) of the raw mix. Second, SLC does not indicate what percentage of the sulfur in the raw mix is volatile. Sulfur in the raw mix can be in several forms, namely: calcium sulfate, magnesium sulfate, sulfides such as pyrites or organically bound sulfur. Only the volatile sulfur compounds (namely: the sulfides and organically bound sulfur) are oxidized and released in the preheater as $SO_2$. Furthermore, 50% to 70% of the volatile sulfur compounds are removed from the preheater exhaust due to "inherent scrubbing".[7] In applying the 70% inherent scrubbing to the 0.73% sulfur in the raw mix SLC has assumed that all of the sulfur in the raw mix is volatile (i.e. sulfides or organically bound sulfur). However, SLC has provided no data to substantiate this assumption. Thus, there is some question as to whether or not the $SO_2$ concentration at the inlet of the SCR system at Greenport will be as high as SLC estimates.

The above analysis shows that the difference in $SO_2$ concentrations at Greenport and Solnhofen is not nearly as great as estimated by SLC. This purported concentration difference is

[7] Terry, M. S., Undated, BACT: What is Achievable with Today's Technologies, Krupp Polysius Corp.

not, therefore, an adequate reason for claiming that the Solnhofen SCR system is not applicable to the Greenport project.

Another reason for dismissing SLC's concerns is the success of SCR systems on Powder River Basin coal-fired boilers. These installations show that SCR systems can be designed for high calcium and high sulfur flue gases. See discussion of Kansas City P&L SCR unit in the Table at Attachment C. In addition, the SCR catalyst suppliers have indicated that $CaSO_4$ formation does not pose a major concern. Note that Alstom Power, Inc, in their letter to SLC dated October 20, 2003, guaranteed an $SO_2$ oxidation rate of less than 0.5%; they also state that they can control fouling and sticky deposits on the catalyst by the type of soot blowing system they have proposed (heated compressed air) and by requiring frequent soot blowing. KWH Catalysts, Inc., Solnhofen's catalyst supplier, also dismisses $CaSO_4$ formation as a major concern. KWH's February 27, 2004 letter to CDM asserts that "The $SO_3$ generated in the process is captured by the large amount of free lime as CaO in the gas stream. $SO_2$ oxidation by the catalyst will have no negative impact on the amount of $SO_3$ formed and subsequently captured." Attachment B, KWH Letter, pp. 1-2. Neither of these catalyst suppliers cites masking from $CaSO_4$ formation as an unmanageable risk to their SCR systems.

SLC also expresses concerns regarding the possible formation of ammonium salts, which can form in SCR systems at temperatures below 580° to 590° F . However, this problem can be avoided by ensuring that the SCR inlet temperature is always 600° F or greater. This can be accomplished with the use of a cyclone preheater bypass duct as discussed in Section 4.4.2 below.

### 4.4 Gas Temperature Ranges, Distribution and Fluctuations

#### 4.4.1 Gas Temperature Issues - Background

SLC identifies several temperature-related factors as important to successful operation of an SCR system. These are: (1) an acceptable normal operating temperature; (2) an even temperature distribution (SLC identifies temperature distributions of up to +/- 30° C (50° F) as acceptable); and (3) avoiding temperature extremes (which may lead to catalyst deactivation or sintering).

#### 4.4.2 Gas Temperature Issues - Risks for the Greenport Project

SLC identifies normal operating temperatures as well as the potential for significant temperature fluctuations at the Greenport plant as potential obstacles to using SCR at the Greenport plant. Among other things, SLC notes that the temperature of the preheater tower exhaust gas, minimum of 300° C (572° F), is slightly lower than the desired minimum inlet temperature of 315° C (600° F) to 325° C (617° F). According to SLC, low temperatures can lead to lower NOx reduction efficiencies and/or higher catalyst activity (leading to possible $SO_2$ oxidation) and to possible ABS/AS formation in the catalyst pores. Concerns regarding the slightly lower than desirable inlet temperature can be resolved by installing a bypass duct around the last preheater cyclone. See Figure 1, included as Attachment E, showing kiln, preheater cyclones, proposed cyclone bypass duct and nominal design temperatures through the process. Assuming that the preheater tower exhaust temperature from the last preheater tower is at the minimum 572° F and its temperature needs to be raised to 600° F, only 3 percent of the 932° F gas stream going into the last cyclone would have to be bypassed to achieve the desired 600° F going into the SCR system. KWH confirmed in its February 27, 2004 letter to CDM that installation of a bypass duct around the last preheater cyclone appeared to be "a reasonable method to address the minimum temperature issue." See Attachment B, KWH Letter, p. 3. Note that similar types of economizer bypasses are commonly used on utility boiler SCR systems. Such an economizer bypass is shown in Figure 2 (in Attachment E) which shows an elevation view of an economizer bypass and SCR system on the Somerset, New York, 675 megawatt power generating station.

In addition, the cyclone bypass duct could be equipped with a bypass damper and flow control system which would automatically regulate the amount of 932° F gas required to achieve a constant temperature of 600° F at the inlet to the SCR system. The flow control system would continuously sense the temperatures at the SCR inlet and at the outlet of the next to last preheater cyclone. If the temperature at the SCR inlet dropped below 600° F, the bypass damper would partially open to send enough 932° F gas to the SCR inlet to raise its temperature to 600° F. Thus, temperature fluctuations at the inlet to the SCR system could be eliminated by the use of a bypass damper and flow control system. Such flow control dampers are commonly used on boiler air supply systems and economizer bypass ducts. Note that the SCR reactor would also have an automatically activated bypass duct around the SCR reactor, so that in the event of high temperature fluctuations (greater than approximately 800° F), automatically controlled dampers would send the hot flue gas to the reactor bypass duct, thus preventing any damage to the SCR catalyst.

As the above summary shows, temperature issues, whether involving normal operating temperatures or temperature fluctuations, are correctable with slight process modifications and therefore should not be a reason for dismissing the use of SCR on the Greenport project.

### 4.5 NOx Inlet Concentration Variability and $NH_3$ Slip

On the issue of NOx inlet concentration variability and $NH_3$ slip, SLC argues that "unlike a coal-boiler SCR application, an SCR system applied to a cement kiln will be faced with highly variable inlet NOx loadings. This situation will create the potential for excessive $NH_3$ slip. SLC Supplemental LAER Analysis, § 4.5, p. 4-35. SLC then states that "for applications like the Greenport Project, elevated $NH_3$ slip levels, coupled with the higher sulfur oxide levels, represent a serious risk." Id. These concerns should be rejected.

In an SCR system, the injected $NH_3$ is adsorbed onto the surface of the catalyst. Thus, there is a reservoir of unused $NH_3$ on the surface of the catalyst which is available to handle sudden peaks in inlet NOx concentrations and thereby enable SCR systems to control fluctuating levels of NOx. SCR systems do not have to overfeed ammonia to handle surges in inlet NOx concentration and so tend to have very low $NH_3$ slip levels. In contrast, SNCR systems, which do not have a catalyst bed, have significant $NH_3$ slip levels because these systems must instantly increase ammonia feed in proportion to any incoming surge in NOx concentration. If the NOx surge abruptly ends, an excess of $NH_3$ is injected into the system. Thus SCR systems have a significant advantage over SNCR with respect to $NH_3$ sip. In fact, according to Tom Lugar at KWH, at least one Canadian cement plant with SNCR is interested in installing SCR systems to eliminate its $NH_3$ slip problems. *See* Telephone conversation between Tom Lugar, KWH, and Frank Sapienza, CDM, on March 16, 2004.

Experience at other facilities suggests that NOx inlet concentration variability does not pose a threat to successful application of SCR. Coal-fired boilers have been operating SCR systems successfully for years despite considerable NOx fluctuations in their flue gases. Figure 2 in EPA's 1997 study of SCR discussed in Section 4.3 above shows pre-SCR NOx levels from one of the coal-fired boilers in the 1997 EPA study. Whether the fluctuations presented in this figure are as great as those from a cement kiln is debatable and depends on the particular plants in question. However, SCR suppliers typically guarantee a $NH_3$ slip of 2 ppmv for any coal-fired boiler SCR application. Considering that 2 ppmv of $NH_3$ is a very small amount of $NH_3$, it does not appear that inlet NOx variability is a significant concern for catalyst suppliers.

With respect to cement plants, SLC ignores the fact that the Solnhofen plant is a cement kiln with all of the inherent variability claimed by SLC and has nevertheless been achieving a high degree of NOx control (approximately 82%) with a low ammonia slip level.[8] Moreover, both KWH and Alstom indicated that they could meet a performance guarantee of 2 ppmv of $NH_3$ for the Greenport plant. Together, these facts indicate that fluctuations in NOx inlet concentrations and $NH_3$ slip do not pose a barrier to installation of SCR at the Greenport plant.

### 4.6 Undesirable Byproduct Formation and Adverse Impact of Byproducts on Downstream Equipment

SLC raises concerns regarding the generation and release of $SO_3$ which they allege could cause corrosion of downstream equipment. Alternatively, SLC argues that the $SO_3$ may react with unused $NH_3$ to form ammonium salts (ABS and AS) which could plug or corrode downstream equipment. Finally, SLC contends that ammonium salts could increase condensable particulate matter levels, making it difficult for the Greenport project to meet its condensable particulate matter emission limit of 0.007 grains/DSCF.

[8] As shown in Figure 2 of the article by Haug et al. concerning Solnhofen, included as Attachment F, the SCR inlet NOx concentration (Rohgas) varies considerably from less than 1000 mg/Nm$^3$ to 2030 mg/Nm$^3$ while the outlet NOx concentration varies from approximately 300 to 726 mg/Nm$^3$ but maintains an average outlet NOx concentration of less than 500 mg/Nm$^3$. Also note that the outlet $NH_3$ concentration is very low and steady, reported at less than 1 mg/Nm$^3$.

As previously discussed, in SCR systems with $SO_3$, $NH_3$ and moisture present, ammonium salts will form at temperatures below 580-590° F. The most assured way to prevent their formation is to continuously control the SCR inlet temperature such that it is always 600° F or greater. This can be accomplished by the use of a cyclone preheater bypass duct as discussed in Section 4.4.2. Regarding the possible release of $SO_3$ as stated by KWH in its February 27, 2004 letter, "the $SO_3$ gas is totally captured by conversion to particulate calcium sulfates and sulfites as it is contacted by the free lime upstream, within, and downstream of the SCR catalyst." Attachment B, KWH Letter, p. 2. Thus, the formation of undesirable byproducts is inherently controlled by the large amount of free lime in the system and can be further controlled by controlling the SCR inlet temperature.

### 4.7 Process Start-up, Shutdown and Malfunction Events

SLC states that an SCR catalyst could be deactivated by "process transient conditions associated with startup, shutdown and malfunction events." SLC Supplemental LAER Analysis, § 4.7.1, p. 4-42. Malfunction events include preheater tower blockage and raw material feed interruption which "could result in severe gas temperature variations at the inlet to the SCR beds." Id. § 4.7, p. 4-42.

SLC's concerns are easily addressed. The SCR system would be equipped with a bypass around the SCR beds so that the SCR catalyst would not be exposed to unacceptably high or low temperatures. For the SCR bypass system to react fast enough to sudden process changes, the cement kiln/preheater system would have to be equipped with flow, pressure and temperature sensors to detect any abnormal or sudden changes in process conditions. A significant change in any key process sensor would trigger an SCR bypass. In addition, the regulatory authority would have to agree that NOx emission limits do not have to be met during malfunction events. This combination of equipment and permit conditions is commonly used by regulators to address start-up, shutdown and malfunction events at complex industrial facilities.

### 4.8 Gas Flow Distribution

#### 4.8.1 Gas Flow Distribution - Background

According to SLC, for an SCR system to function efficiently, "the gas flow distribution across the reactor cross-section must be reasonably even" or various problems may occur including increased catalyst volume requirements, increased $NH_3$ slip, and lower NOx reduction levels. SLC Supplemental LAER Analysis, § 4.8.1, p. 4-44. Although various techniques and equipment are available to minimize the impact of uneven distribution, SLC questions whether these devices would work at the Greenport plant.

#### 4.8.2 Gas Flow Distribution - Risks for the Greenport Project

The success of the Solnhofen plant indicates that the gas flow problems associated with installing SCR at a cement plant can be resolved. As it has throughout its report, SLC argues that there are differences between the Greenport project and Solnhofen that "could prove significant". SLC Supplemental LAER Analysis, § 4.8.2, p. 4-45. Among other things, SLC identifies the "extreme high dust loading of about 60 $g/Nm^3$ and associated high gas velocity (*i.e.*, 20 m/s) projected for the Greenport project" as possible obstacles to successful operation of SCR. Id. As previously noted, however, the Solnhofen plant has estimated dust loadings of 80 $g/Nm^3$, *higher* than the dust loading estimated for Greenport, suggesting that dust loading does not pose an obstacle to successful implementation of SCR at Greenport.

The use of high gas velocities at Greenport (20 m/sec, equivalent to 3937 ft/min) is most likely required to transport the lime (CaO) dust through the system. Thus, it is reasonable to assume that similar gas velocities are used at Solnhofen and at most other similar cement manufacturing plants.

Moreover, SLC states that there may be problems getting the proper injection and dispersion of ammonia and gas flow distribution into the catalyst and that flow modeling will be required. These flow distribution problems were not issues at Solnhofen. Even though the flow rates at Greenport are estimated to be about 4.75 times greater than at Solnhofen, it should be possible to design for the larger flue gas flow rate. Note that SCR systems on coal-fired power plants routinely handle flows 7 to 20 times greater than the projected flue gas flow for the Greenport project. As indicated in the table at Attachment C, the gas flow for the Kansas City P&L SCR system is 23 times greater than the flow for the Greenport plant. Also, it is noteworthy that none of the SCR suppliers raises this issue as a concern or risk to the project. Thus, gas flow distribution should not be a problem.

**4.8A NOx Removal Levels at Solnhofen** [NOTE: This section does not correspond to a section in SLC's Supplemental LAER Analysis.]

At various locations in the SLC Supplemental LAER Analysis, the report makes reference to the allegedly modest NOx reductions obtained at the Solnhofen facility. In particular, SLC calculates that Solnhofen has achieved about a 40% reduction in NOx emissions using SCR. *See, e.g.*, SLC Supplemental LAER Analysis, § 4.2.2.2, p. 4-20. By comparison, SLC anticipates achieving a 40% percent reduction using the combination of MSC and SNCR proposed as LAER. Assuming SLC's estimate of Solnhofen's NOx emission reductions were correct, DEC would have no reason to require SCR as LAER. In fact, however, Solnhofen is achieving reductions in NOx emissions of approximately 82% using SCR, approximately twice the reductions calculated by SLC (and approximately twice the reduction SLC estimates achieving using MSC and SNCR).

This discrepancy is apparently the result of a calculation error. SLC's consultant calculated NOx control levels at Solnhofen by comparing average NOx emissions in 2002 when SCR was used (439 mg/Nm$^3$) to average NOx emissions in 1999 and 2000 (736 mg/Nm$^3$), prior to installation of SCR. This calculation yielded a NOx control level of 40.4% ((736-439)/736). However, the consultant apparently did not realize that the Solnhofen plant was operating an effective SNCR system in 1999 and 2000. To determine the true NOx control efficiency achieved using SCR, it is necessary to compare the NOx emission rate in 2002 (when the SCR system was fully operational) to the facility's uncontrolled NOx emission rate.

In their February 27, 2004 letter to CDM (discussed in Section 4.10.2C below), KWH, Solnhofen's catalyst supplier, included an overview of operation of the SCR system at the Solnhofen plant. According to KWH, the average NOx inlet to the facility is 2500 mg. *See* Attachment B, KWH Letter, p. 3. Comparing the controlled NOx emission rate of 439 mg/m$^3$ to the uncontrolled NOx rate (2500 mg/m$^3$), yields a NOx control efficiency of 82.4% ((2500-439)/2500), not 40.4% as estimated by SLC. This result is consistent with the minimum performance guarantee of 85% NOx reduction offered by KWH in its February 27, 2004 letter to CDM. Attachment B, KWH Letter, p. 1. It is also consistent with the SCR performance results reported by Solnhofen's plant manager in earlier conversations with CDM.[9]

[9] As previously noted, representatives of CDM spoke with the manager of the Solnhofen facility in July 2002. Mr. Bucher stated that when the system was operating with SNCR only, its NOx emissions were 700-800 mg/m$^3$ (2.8-3.2 lbs. NOx/ton of clinker). With the SCR system, the plant had reduced NOx emissions and was achieving the applicable German regulatory standard of 500 mg/m$^3$ (2.0 lbs. NOx/ton of clinker). Also, the plant was using one-tenth as much ammonia with SCR as it used when operating with SNCR.

Moreover, the Solnhofen facility arguably is not achieving its full NOx reduction potential. The SCR system at Solnhofen is currently meeting the emission limit set by the German government of 500 mg/$m^3$ of NOx. To achieve this requirement, Solnhofen only needed to equip the SCR with three of a possible five layers of catalyst. Provision was, however, included in the SCR design to achieve a potential future limit of 200 mg by adding the additional catalyst layers. Attachment B, KWH Letter, p. 3. These facts, taken together, show that SCR has the potential to achieve NOx reductions significantly greater than those possible with MSC and SNCR.

## 4.9 Summary of the Risks of Applying SCR to the Greenport Project

None of the technical obstacles to using SCR raised by SLC preclude its use. In some cases, these obstacles have arisen at other facilities and been successfully addressed through SCR/catalyst design (e.g., catalyst poisoning, catalyst plugging and fouling, NOx reduction efficiency and $SO_2$ oxidation). In other cases, the "obstacle" is not, in fact, an obstacle at all (e.g., "sticky deposits," NOx inlet concentration variability and ammonia slip). In still other cases, the "obstacle" can be addressed through minor process changes (e.g., gas temperature ranges, distributions and fluctuations, formation of ammonia salts). SLC's concerns regarding the application of SCR at the Greenport plant can readily be addressed through proper design and operation of plant and the SCR system; they are not insurmountable obstacles to the successful use of SCR.

## 4.10 Vendor Proposals to Supply SCR for the Greenport Project

As summarized in SLC's Supplemental LAER Analysis, SLC solicited bids from SCR system suppliers for the following purposes:

- To determine if responsible suppliers are in a position to design and guarantee the performance of an SCR system for the Greenport Project's kiln;

- To confirm the validity of vendor claims that SCR is "commercially available" for the Greenport Project by requiring vendors to respond to a site-specific specification that defines the relevant properties of the Greenport Project's kiln and its exhaust stream;

- To require from the vendors submission of relevant experience and data to allow an assessment of the applicability of their experience to Greenport; and

- To satisfy the request of NYSDEC that SLC provide information from vendors regarding SCR system guarantees for the Greenport Project. SLC Supplemental LAER Analysis, § 4.10, p. 4-50.

SLC prepared a bid specification document and submitted it to four vendors with experience in developing SCR. The Bid Specification contained criteria relating to NOx reduction efficiency, $NH_3$ slip, $SO_2$ oxidation, gas-side pressure loss, turndown capability, catalyst life, SCR system availability, and minimum acceptable performance. SLC also asked that vendors provide certain information "necessary to allow SLC to evaluate the adequacy of the proposed SCR system design, and to evaluate the vendor's relevant experience in designing SCR systems." *Id.* p. 4-53.

**4.10.2 Results**

SLC did not receive any bids in response to the Bid Specification which it considered satisfactory. Two of the four vendors – Lurgi PSI, Inc. and Babcock & Wilcox – declined to bid. KWH submitted a "Budgetary Bid Proposal" which, according to SLC, was not a firm bid and was deficient in other respects. Alstom Power, Inc. submitted a proposal containing "preliminary technical data and indicative information," which SLC also contends did not satisfy its demand for a firm bid and was otherwise deficient. SLC points to the results of this bidding process as further evidence that SCR is not technically feasible or commercially available for the Greenport project.

As discussed in greater detail below, SLC's bid process pre-ordained the results it obtained. Among other things, the Bid Specification was unreasonably strict, making it virtually impossible for any vendor to satisfy it. Moreover, the bid process offered no opportunity for discussion or negotiation. Vendors thus were given no opportunity to work with SLC to accommodate SLC's concerns.

**4.10.2A Problems with SLC's Bid Specification** [NOTE: This section does not correspond to a section in SLC's Supplemental LAER Analysis.]

The main body of SLC's Bid Specification is contained in Attachment 2 of SLC's Supplemental LAER Analysis. A summary of the key performance specification requirements can be found in § 4.10.1 of that Analysis (pp. 4-51 to 4-54). These specifications were unreasonably strict and/or inappropriate in the following key respects.

- ***NOx Reduction Efficiency.*** SLC required vendors provide a system designed to achieve a 90% NOx reduction efficiency on a 30-day rolling average. According to SLC, the number was based on an e-mail from Tom Lugar, CEO, KWH, to EPA Region 2, in which Mr. Lugar purportedly asserted that NOx reduction guarantees of 90 to 93% could be provided. A single e-mail from a single supplier is not, however, an appropriate or rational basis for setting a NOx reduction efficiency level. As a general rule, equipment vendors in initial responses typically state their products' optimal performance. The vendor and customer then work out mutually agreeable and achievable performance levels based on the customer's needs and the vendor's capabilities. In this case, SLC should have asked the SCR suppliers to provide a reasonable guarantee for a NOx removal efficiency, rather than demanding that suppliers guarantee an unreasonable NOx reduction level and then rejecting as inadequate bids that did not meet that standard. SLC's demand that bidders guarantee a 90% NOx reduction is particularly unreasonable given that SLC's LAER alternative (MSC and SNCR) is only expected to achieve a 40% emission reduction.

- ***Minimum Acceptable Performance.*** Another major criticism of SLC's Bid Specification is that it required the SCR system to meet all performance criteria "at any time and under any operating conditions". There were no conditions or limitations put on the performance requirements. Typically, a vendor's performance requirements are guaranteed for a well defined range of operating conditions (such as flue gas flow rate, temperature, composition, fuel use, fuel characteristics, process feed characteristics, etc.). SLC's Bid Specification, by comparison, required the NOx reduction, ammonia slip, $SO_2$ and gas side pressure loss criteria to be met "at any time under any operating condition". This requirement is unrealistic. No vendor would make a commercial offer under these conditions. Vendor guarantees typically require that the plant be properly operating at stable, continuous conditions and, in the case of SCR, that the system be operated and maintained in accordance with the catalyst supplier's Operations and Maintenance Manual. The SLC Bid Specification did not contain any of these typical conditions of guarantee.

- ***No Flexibility to Address Areas of Concern.*** SLC's Bid Specification did not allow for flexibility to address areas of concern. For instance, the Bid Specification called for SCR inlet temperatures of 320° C. To the extent temperatures at the Greenport plant might be slightly lower, this potential problem could likely be solved by installing a bypass duct around the last preheater cyclone as discussed in Section 4.4.2. However, SLC leaves no room for consideration of such a technique even though bypass ducts are commonly used on economizers on power plants.

- ***Insistence on Commercial Guarantees Up Front.*** SLC in its Bid Specification insists on commercial guarantees on unreasonable performance criteria without any conditions of guarantee. Typically, on an innovative application a customer will have detailed discussions with an equipment supplier to determine what is realistically possible before commercial guarantees are even mentioned. The insistence of SLC on commercial guarantees up front put the catalyst suppliers on notice that this customer was not serious about purchasing an SCR system.

SLC's insistence on these strict Bid Specifications is ironic in light of the guarantee it received from Krupp Polysius for the SNCR system. As discussed in Section 1.5 above, Krupp Polysius provided no ammonia slip guarantee, did not specify the turndown capability of the system, and included no information regarding overall system availability.

**4.10.2B Problems with SLC's Bid Process** [NOTE: This section does not correspond to a section in SLC's Supplemental LAER Analysis.]

Although the Bid Specification itself posed a major obstacle to identifying companies that could potentially supply SCR technology to the Greenport project, the effort was not helped by SLC's approach to the bidding process. As described in the SLC Supplemental LAER Analysis, vendors were expected either to meet the Bid Specification or to specifically take exception to the performance requirements that caused them concern. The Bid Specification documents did not encourage dialogue between the vendors and SLC. In fact, in discussions with CDM, representatives of the various vendors characterized SLC's tone in responding to vendor questions as judgmental, non-cooperative and, at times, adversarial.

Evidence of SLC's rigid approach to the bidding process can be found in the letters submitted by SLC responding to the proposals submitted by KWH and Alstom. In each letter, SLC provides:

> The Specification detailed exactly what information SLC required to evaluate whether SCR (and its associated emission rate) was technically feasible for the Greenport Project. This required information, as you know, was not optional--the failure to supply SLC with this information would, in essence, result in a non-bid. Based on your . . . Proposal [you have] failed to provide a bid upon which SLC can determine technical feasibility of SCR for the Greenport Project.

*See* SLC Supplemental LAER Analysis, Attachment 2, Sept. 30, 2003 letter from P. Lochbrunner, SLC, to T. Lugar, KWH; Oct. 14, 2003 letter from P. Lochbrunner, SLC, to J. Holbrook, Alstom. These letters reflect SLC's rigid approach to the bidding process. Bidders were required to satisfy each and every criteria of SLC's Bid Specification or face rejection.

SLC compounded the problem by providing only a limited period of time for the vendors to submit a bid and refusing to enter into a dialogue on resolving questions the vendors raised. Despite the multiple extensions that SLC received to submit its analysis, it never informed the vendors of those extensions or returned to the vendors seeking further information when the deadlines were extended.

Illustrative of SLC's intention to avoid a meaningful exploration of the SCR issue is its mischaracterization of the Lurgi bid response. While Lurgi declined to submit a bid, its August 29, 2003 letter said that commercial release of its SCR currently in development "could still most likely be some matter of months away". SLC Supplemental LAER Analysis, Attachment 2, August 29, 2003 letter from C. Leivo, Lurgi, to P. Lochbrunner, SLC. To the best of our knowledge, SLC has not followed-up with Lurgi concerning the status of its SCR development efforts since August.

Moreover, the best of our knowledge, SLC also failed to follow up on questions raised by Alstom in response to SLC's letter rejecting Alstom's proposal. SLC's September 30, 2003 rejection letter contained a list of deficiencies that would need to be addressed for Alstom's bid package to be successful. By letter dated October 20, 2003, Alstom provided additional information in response. To the best of our knowledge, SLC never responded to this letter, essentially ignoring Alstom's efforts to address SLC's concerns and develop a workable SCR system.

Where, as here, a facility is seeking information from vendors concerning innovative technologies, the type of "take it or leave it approach" embodied in SLC's bid process is inappropriate. Vendors need an opportunity to talk with facility personnel and learn more about the specifics of the proposed project both generally and in relation to specific bid criteria. Because there are typically many questions surrounding the application of innovative technologies, this type of dialogue is crucial to ensuring that both the vendor and the facility understand the potential benefits and limitations of a technology as applied at a particular facility. The bid process followed by SLC discouraged this type of dialogue. As a result, vendors were denied the opportunity to work with SLC to develop a solution to the various problems identified by SLC in its SCR analysis, virtually ensuring that the bid process ended in failure.

As SLC is aware, LAER is not established until the final construction permit is issued. Applicants for a nonattainment NSR permit thus are under a constant obligation to investigate new technologies to determine if they will result in a lower emission rate. SLC's apparent unwillingness to follow up with SCR vendors suggests a lack of enthusiasm for SCR and for its obligations under NSR.

**4.10.2C CDM's Revised Bid Specifications** [NOTE: This section does not correspond to a section in SLC's Supplemental LAER Analysis.]

Given the problems with the SLC Bid Specification, CDM decided to rewrite the Bid Specification to include more reasonable terms. CDM used a typical SCR Supplier's Proposal as a model of what should be reasonably expected by a customer. Based on that model, CDM included following performance guarantees:

1. NOx reduction efficiency of 85% but only when the system is at stable, continuous conditions. Stable, continuous conditions were defined as operation of the system such that process parameters were between well defined minimum and maximum levels. These levels were taken from SLC's Bid Specification.

2. $NH_3$ slip shall not exceed 2 ppmv when the system is at stable, continuous conditions.

3. $SO_2$ oxidation shall not exceed 1.0 mole % when the system is at stable, continuous conditions.

4. Gas side pressure loss shall not exceed 6 inches water column when the system is at stable, continuous conditions.

5. The SCR system must have turndown capability within the process parameter ranges presented in Item 1 above.

6. The average catalyst life shall be 24,000 hours of operating time.

7. The SCR system shall be available at least 98% of the time that the cement manufacturing plant is operating at stable, continuous conditions.

8. If the SCR fails to meet the NOx reduction efficiency stated in Item 1 or the $NH_3$ slip limit stated in Item 2, then the SCR system supplier shall correct the failure. If the SCR supplier can not correct the deficiency, then the supplier must pay liquated damages based on the cost to the purchaser of the excess NOx emissions to the atmosphere.

CDM then mailed the bid specifications to the following SCR suppliers: KWH Catalysts, Inc., Alstom Power, Haldor Topsoe, Hitachi America, Ltd., Cormetech Inc., and Argillon Inc. (formerly Siemens). Initially, CDM contacted all four of the SCR suppliers to which SLC sent the Bid Specification (KWH, Alstom, Lurgi and Babcock & Wilcox) by telephone. Based on these telephone calls it became clear that Lurgi and Babcock & Wilcox were not in a position to make a guarantee statement regarding their SCR system as applied to the Greenport project. Therefore, CDM did not send the revised Bid Specification to those companies. In contrast, KWH, Alstom and Haldor Topsoe (the proposed catalyst supplier for Alstom) all indicated a willingness to reconsider the suitability of their catalyst for the Greenport project provided more reasonable performance criteria were required. In addition to these three SCR suppliers, CDM contacted Hitachi, Cormetech and Argillon by telephone. During the course of CDM's investigations, it was noted that these three companies had extensive experience applying SCR systems to coal-fired power plants and, in particular, that all of these companies had SCR installations on power plants burning PRB coal with high calcium content. Although none of the companies had installed an SCR system on a cement plant, they all said they would consider the use of their catalyst for the Greenport project. Copies of CDM's revised Bid Specifications are presented in Attachment A.

Obviously, FOH is at an inherent disadvantage in obtaining bids for a cement plant for which it is not the contracting party. Vendors will naturally be reluctant to deal with an entity that will not be awarding the bid, let alone a critic of the plant. Nevertheless, CDM has received three responses to its revised Bid Specification. Perhaps the most interesting response came from KWH, Solnhofen's catalyst supplier. *See* Attachment B, KWH Letter. Basically, KWH agreed to all of the performance requirements in the revised Bid Specification with the following exceptions:

1. The minimum 85% NOx reduction will be met provided that the inlet temperature to the SCR catalyst is a minimum of 315° C (600° F).
2. KWH would not guarantee any $SO_2$ oxidation limit because it is unnecessary. According to KWH, "the $SO_3$ generated in the process is captured by the large amount of free lime as CaO in the gas stream. $SO_2$ oxidation by the catalyst will have no negative impact on the amount of $SO_3$ formed and subsequently captured." KWH went on to note that oxidation cannot be measured because the $SO_3$ gas is totally captured by conversion to particulate calcium sulfates and sulfites as it is contacted by the free lime upstream, within and downstream of the catalyst. Attachment B, KWH Letter, p. 1-2.
3. Turndown requirement could be guaranteed with the exception of $SO_2$ oxidation and provided the SCR inlet temperature is maintained at a minimum of 600° F.
4. A catalyst life of 16,000 hours was guaranteed. However, KWH stated that they are removing a catalyst test element from the Solnhofen reactor and will be performing tests on it. Depending on the results of this testing, KWH stated that they may be able to offer a 24,000-hour catalyst life guarantee.
5. Regarding failure to meet performance, KWH took exception to the open ended liquated damages requirement and requested that liquid damages should not exceed 100% of the Contract Price paid to the vendor.

KWH also stated that the proposed bypass duct around the last preheater cyclone appeared to be a reasonable means of maintaining the minimum SCR inlet temperature of 600° F.

CDM also received responses from Alstom and Hitachi. Alstom declined to respond, stating that it "is not in a position to formally respond to questions from a party who is not contracted directly with, or an agent of, St. Lawrence Cement (SLC)." Attachment B, Alstom Letter. It is reasonable to assume that Haldor Topsoe (Alstom's proposed catalyst supplier) took a similar position; however, no formal response has been received from Haldor Topsoe. On March 23, 2004, CDM received an e-mail response from Hitachi, which is included in Attachment B. Hitachi declined to submit a proposal for an SCR system for a cement plant citing concerns relating to high dust loading and high CaO loading and what it considered to be very high performance and life duration for the catalyst. Notably, Hitachi's concerns were not echoed by KWH in its response to CDM or Alstom in its response to SLC. KWH, which has experience with SCR at cement kilns, did not identify the issues raised by Hitachi as a concern. CDM also believes that if more time were available to engage in discussion with Hitachi regarding operational flexibility and engineering issues, that Hitachi might be willing to reconsider their reservations concerning SCR.[10]

**4.10.2D Conclusions Regarding the Bidding Process** [NOTE: This section does not correspond to a section in SLC's Supplemental LAER Analysis.]

SLC's effort to solicit vendors for purposes of determining whether SCR is commercially available for the Greenport plant represents, at best, a token gesture. The Bid Specification submitted was so unreasonably stringent that SLC virtually assured that no supplier would bid successfully. SLC also showed no interest in working with vendors who expressed an interest in bidding to develop solutions to issues identified during the bidding process. In light of these factors, it is no surprise that SLC did not receive a "satisfactory" bid.

The errors in SLC's approach to the bidding process are illustrated by CDM's efforts to solicit vendor interest in SCR for the Greenport plant. When presented with a more realistic Bid

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10 To date, Cormetech and Argillon have not responded. Cormetech has indicated that they did not initially forward the Bid Specification to the proper party and, as a result, are still in the process of developing a response. CDM did not become aware of Argillon's experience on PRB coal power plants until late in the evaluation process.

Specification at least one vendor indicated that it could meet virtually all of the criteria for supplying SCR to Greenport outlined in that specification. At least one vendor was, however, reluctant to submit a response to anyone but the potential purchaser, i.e., SLC. This response suggests that if SLC had submitted a more realistic Bid Specification (and had reached out to more suppliers) it would likely have received a more favorable response.

SLC cannot be permitted to evade its obligations to satisfy LAER by submitting unreasonably strict bid specifications, ignoring efforts by vendors to work through issues raised by those specifications, and then declaring that SCR is not "commercially available". FOH believes that DEC has enough information to conclude that vendors are available to provide SCR to Greenport. Any lingering concerns could be addressed by requiring SLC to submit a revised RFP (under DEC's supervision) that contains more realistic bid specifications and ensuring that SLC follows through with vendors to ensure that any outstanding issues are resolved.

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Therefore, the Bid Specification was sent to Argillon relatively late. Nevertheless, Argillon has stated that they intend to respond.

## 5.0 Legal Basis of SCR as NOx LAER for Greenport Project

The SLC facility will be a "major source" of $NO_x$ and must therefore comply with the requirements of the nonattainment NSR program. In New York, DEC has adopted its own nonattainment NSR regulations, which are set forth at 6 NYCRR Subpart 231-2. These regulations establish stringent emission control and other requirements intended to ensure that newly constructed or modified major sources located in areas designated as nonattainment for one or more contaminants do not adversely affect existing air quality. Because the air in nonattainment areas fails the national ambient air quality standards (NAAQS), these requirements are much stricter than those applicable to sources regulated under the PSD program. Like the PSD program, facilities covered by the nonattainment NSR program must obtain a preconstruction permit from DEC prior to commencing construction. 6 NYCRR § 231-2.3(a). However, the standards applicable to nonattainment NSR sources are stricter than those for PSD sources. In particular, sources are expected to achieve the "lowest achievable emission rate" or "LAER". To ensure that the strictest possible limits are imposed, LAER "is not established in final form until the permit for the proposed . . . major facility is issued." 6 NYCRR § 231-2.5(c). Applicants for nonattainment NSR permits thus are expected to continually investigate new technologies and stricter emission limits throughout the permitting process so as to ensure that the limits ultimately set truly are the "lowest achievable emission rate."

### 5.1 LAER Definition

LAER is defined by New York regulation as the "most stringent emission limitation achieved in practice or which can reasonably be expected to occur in practice for a category of emission sources taking into consideration each air contaminant which must be controlled." 6 NYCRR § 200.1(ak).[11] According to EPA's 1990 Draft New Source Review Workshop Manual,[12]

> The emissions rate may result from a combination of emissions-limiting measures such as (1) a change in the raw material processed, (2) a process modification, and (3) add on controls. The reviewing agency determines for each new source whether a single control measure is appropriate for LAER or whether a combination of emissions-limiting techniques should be considered.

NSR Workshop Manual, p. G.3. In making that decision, the reviewing agency can require consideration of technology transfer for similar processes and gas streams. *Id.*

Unlike Best Available Control Technology (BACT) required under the PSD program, "the LAER requirement does not consider economic, energy, or other environmental factors."[13] NSR Workshop Manual, p. G.4. If another source in the industry is using a particular control

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11 The comparable federal regulations define LAER as the most stringent emission limitation achieved in practice by a class or category of sources or the most stringent emission limitation contained in any State Implementation Plan (SIP) for sources in that category, whichever is stricter. 40 C.F.R. § 51.165(a)(xiii). As SLC notes, the federal and state definitions have been found to be comparable. Accordingly, EPA guidance is relevant to understanding LAER in New York.

10 Although the NSR Workshop Manual was issued in 1990 and remains a draft document, it is still considered one of EPA's primary resources for understanding the PSD and nonattainment NSR programs.

11 The federal PSD regulations, which are delegated to New York, define BACT as:

> an emissions limitations (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to a regulation under the Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through the application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant.

40 C.F.R.§ 52.21(b)(12).

strategy, it is essentially presumed that the costs of installation are not prohibitive and that the strategy should be pursued as LAER by the source seeking approval.

LAER is intended to be a "technology forcing" standard. Applicants required to meet LAER are requesting permission to install a new source or modify an existing source that will increase emissions of particular contaminants for which the area already is in nonattainment. Essentially, the applicant is asking permission to discharge more of a particular contaminant into a region that already is experiencing serious air pollution problems with respect to that contaminant. To minimize the impact of the new or modified source on this already polluted area, the law requires the new source to implement a control strategy that reflects the "lowest achievable emission rate" achieved in practice by other similar sources without regard to cost, energy or other environmental factors. If other sources outside the particular source category are achieving stricter control levels and the technology can be transferred to the NSR source, the source will be expected to install it. NSR Workshop Manual, p. G.3. In this way, the LAER requirement gradually forces the development of better and better control strategies. *See* H.R. Rep. No. 294, p. 1294 (1977) (discussing technology-forcing aspects of the LAER).

## 5.2 Test One: "Achieved in Practice . . . For a Category of Emission Sources"

### 5.2.1 Source Category Defined

As noted above, LAER is defined by New York regulation as the "most stringent emission limitation achieved in practice, or which reasonably can be expected to occur in practice for a category of emission sources taking into consideration each air contaminant which must be controlled." In this case, the existence of the Solnhofen cement plant in Germany is strong evidence that SCR (and the emission rate resulting from application of that technology), has been achieved in practice for cement plants. In response, SLC argues vigorously that the Solnhofen cement plant and the proposed Greenport cement plant are *not* in the same source category, and that the emissions reductions achieved at Solnhofen using SCR are not, therefore, LAER for Greenport.

In support of its argument, SLC begins by noting that many federal and state programs, including the federal New Source Performance Standards (NSPS)[14] and Maximum Achievable Control Technology (MACT) standards under Title III of the Clean Air Act (CAA),[15] rely on category classifications and sub-classifications. However, there are important distinctions between these programs and LAER under NSR. Both the NSPS and MACT are source category-specific, technology-based standards. Under each of these programs, EPA's mandate is to identify categories of emission sources that require control and adopt standards for these source categories based on the technologies available at the time the standards are adopted as regulations. Under the NSPS program, for example, EPA has adopted regulations for approximately 80 source categories; within each category, EPA has set different emission limits or other standards for the various types of equipment commonly found at facilities in that category. The NSPS apply to all sources in the category and do not change regardless of improvements in technology. EPA can change a NSPS only by amending the regulation.

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14 The NSPS establish technology-based emission standards for new or modified stationary sources of pollutants in specific source categories. CAA § 111, 42 U.S.C. § 7411. These standards of performance are expected to reflect the degree of emission reduction achievable through application of the best system of emission reduction, taking into consideration cost, non-air impacts and energy requirements. The NSPS essentially function as a "technological floor," ensuring that all new or modified sources in a particular source category meet certain minimum standards.

15 Under CAA § 112, EPA is required to develop a list of categories that emit certain hazardous air pollutants (HAPs) in significant quantities and to issue "MACT" standards for new and existing sources in these categories based on the degree of emission control achievable through the application of technologies that are used by the best performing sources in a given source category, with stricter standards for new sources. 42 U.S.C. § 7412.

Similarly, the MACT standards under Title III of the CAA also are source category-specific standards that can be changed only by regulatory amendment. Although the statute contains certain provisions that call for the establishment of case-by-case MACT,[16] the core standards are set on a source category-specific basis.

The concept of source category under the nonattainment NSR and PSD programs is considerably more fluid. Under these programs, the required emission rates/controls are established on a case-by-case basis, taking into account what other facilities are doing at the time the facility is permitted. As technologies improve, LAER and BACT become increasingly more stringent. In the case of nonattainment NSR, applicants are expected to look at the emission rates being achieved by other facilities in the same source category. However, this is merely the first step in assessing LAER. Applicants also must consider whether technology can be transferred from other similar processes or gas streams to achieve a lower emission rate. *See* Memo from J. Calcagni, Director, EPA Air Quality Management Division, to D. Kee, Director Air and Radiation Division, EPA Region V, *Transfer of Technology in Determining Lowest Achievable Emission Rate (LAER)* (Aug. 29, 1988) (hereinafter "EPA Technology Transfer Memo"). Thus, unlike NSPS and MACT, the focus of LAER is not on the source category of the facility being permitted but on the nature of the process and the emissions it generates. The key question is not whether two sources are in the same source category but whether a particular technology can feasibly be installed given the processes and gas streams at the facility being

[16] Under CAA § 112(g), 42 U.S.C. § 7412(g), where EPA has not yet issued a MACT standard for a specific source category, the permitting agency may be required to impose a standard prior to authorizing construction or modification of a major HAP source. Similarly, under the so-called "MACT Hammer Rule," where EPA fails to issue a MACT standard for a particular source category in accordance with established deadlines, states may be required to set MACT for sources in that category. CAA § 112(j), 42 U.S.C. § 7412(j).

permitted. This focus on feasibility ensures that the technology forcing goals of NSR are achieved.

The emphasis of LAER on technical feasibility is illustrated by the DEC decisions cited by SLC in which DEC rejected attempts by petitioners to require newly constructed power plants to install SCONOx rather than SCR to control NOx emissions. In these cases, DEC staff considered the technologies available to control NOx and concluded that SCONOx was too risky for the types of facilities under review. These decisions were upheld during the siting process following a careful review of the technical feasibility of installing SCONOx in light of facility size, fuel choice, and other considerations.

The danger of SLC's narrow focus on source category rather than technical feasibility is illustrated by EPA's decision in *In re: Knauf Fiber Glass, GMBH*, 1999 WL 64235, PSD Appeal Nos. 98-3 through 98-20 (Feb. 4, 1999). In that decision, EPA remanded a state BACT determination back to the local permitting agency following an extensive review of the state's BACT assessment process. As part of its initial review, the state had concluded that Knauf could not be required to install controls similar to those used at another similar fiberglass plant that deployed different processes because such a requirement would amount to "redefining the source." Following a detailed review, the EPA Appeals Board concluded that while the fiberglass manufacturing industry is "indeed characterized by specialized processes and raw material mixtures that vary from firm to firm and product to product [,] the pollution control devices that individual companies apply are legitimate avenues of inquiry, which must be fully explored." *Id.* at 23. In so finding, the Board rejected Knauf's argument that the only facility that was suitable for comparison was its own facility in another state. According to the Board,

> While the Lanett plant may well be the most similar to the

> proposed plant because Knauf intends to use the Lanett process technology in Shasta Lake, that fact should not foreclose Knauf's obligation to look at its competitors' plants in identifying potential control options. The approach used by Knauf has the potential to circumvent the purpose of BACT, which is to promote use of the best control technologies as widely as possible. If a company can claim that the only facilities similar to a proposed project are its own facilities, this objective of the BACT program would not be fulfilled.

In this case, SLC is attempting to foreclose consideration of Solnhofen by arguing that the plant is in a different source category than Greenport. As in *Knauf,* however, this approach has the potential to circumvent the achievement of LAER. SLC must no doubt concede that Solnhofen and Greenport are both cement plants. Once that point is conceded, the focus of the analysis must turn to whether the emission reductions being achieved by Solnhofen using SCR can "reasonably be expected to be achieved" at Greenport.

Consistent with SLC's Supplemental LAER Analysis, CDM has reviewed the following factors in assessing the technical feasibility of installing SCR at Greenport: (1) gas stream characteristics; (2) regulatory differences; (3) operational differences; (4) fuel differences; (5) size and production capacity differences; and (6) catalyst performance. As discussed in Section 4.0 above and summarized briefly below, these factors do not pose an obstacle to the installation of SCR to achieve LAER. [17]

#### 5.2.1.1 Gas Stream Characteristics

SLC restates its case that the high levels of $SO_2$ at the inlet to the SCR catalyst at

[17] SLC identifies each of these listed factors as a basis for concluding that the Solnhofen and Greenport plants are not in the same source category. For example, SLC argues that the two facilities have different gas stream constituents and concentrations and are therefore in different "source categories". SLC also argues that the two plants: (1) are subject to different regulatory restrictions and operating conditions; (2) use different fuels; (3) have different size and production capacities and that they are, as a result, in different source categories. At bottom, however, the issue is not whether the two cement plants are in the same source category but whether the emission reductions achieved by Solnhofen can also be achieved by Greenport despite the differences between the two plants.

Greenport increase the likelihood of catalyst masking from formation of $CaSO_4$. SLC states that the projected concentration of $SO_2$ for the Greenport Project is estimated to be nearly 300 times the level of $SO_2$ present at Solnhofen and that this critical difference in gas stream characteristic means that Greenport should not be included in the same "source category" as Solnhofen. In addition, SLC argues that the high $SO_3$ levels projected for Greenport can react to form a sulfuric acid mist that may result in the formation of a visible plume. Alternatively, SLC states that the high $SO_3$ levels could react with the excess $NH_3$ and form ABS and AS which could damage the catalyst. Finally, SLC states that the concentration of volatile catalyst poisons (arsenic, sodium, and potassium) at Greenport "could be higher than the concentrations at Solnhofen."

As pointed out in Section 4.3, SLC has made incorrect assumptions regarding the $SO_2$ concentration at the inlet to the SCR system at Solnhofen. The $SO_2$ concentration at Solnhofen is significantly greater than 6 mg/Nm$^3$ and could be as high as 400 mg/Nm$^3$ to 733 mg/Nm$^3$. Using these estimates, the Greenport $SO_2$ concentration would only be 2.3 to 4.3 times greater than Solnhofen's. In addition, there is serious question as to the validity of SLC's projected $SO_2$ concentration for Greenport (1700 mg/Nm$^3$) since SLC has not provided any back-up data to confirm this concentration. Thus, the $SO_2$ concentration at Greenport may be greater than that at Solnhofen but not so much greater that it justifies including Greenport in a different source category than Solnhofen.

Regarding SLC's concern that the high $SO_2$ level at Greenport will cause $CaSO_4$ masking, the SCR experience at Solnhofen shows that $CaSO_4$ masking was not a problem even though Solnhofen had moderately high $SO_2$ levels and high calcium levels. Also, the experience at PRB coal boilers shows that SCR systems can be designed for high calcium and high sulfur flue gases. In addition, both KWH and Alstom have indicated that $CaSO_4$ formation does not pose a major concern. Alstom states that $SO_2$ oxidation can be limited to less than 0.5% and that fouling of the catalyst can be controlled by their soot blowing system. KWH states that any $SO_3$ generated in the process will be captured by the large amount of free lime as CaO in the gas stream. Thus, SLC's concerns regarding $H_2SO_4$ or ABS and AS formation are unfounded. In addition, the possible formation of ABS and AS is addressed by the fact that the $NH_3$ slip for an SCR is very low (guaranteed at less than 2 ppmv) and also by maintaining an SCR inlet temperature of 600° F. This can be accomplished with a cyclone bypass duct as explained in Section 4.3. Furthermore, the SCR experience at Solnhofen and the PRB coal boilers demonstrates that SLC's concerns regarding $H_2SO_4$ and ammonium salt formation and the possible catalyst deactivation from volatile catalyst poisons lack merit.

#### 5.2.1.2 Regulatory Differences

SLC states that the Greenport plant is subject to a visible emission standard while the Solnhofen plant is not. According to SLC, this difference is significant because there is increased potential for oxidation of $SO_2$ to $SO_3$ if the Greenport plant has to achieve a high degree of NOx reduction (e.g. 90%) and, therefore, an increased potential to form sulfuric acid ($H_2SO_4$) mist and a visible plume. SLC also states that since Solnhofen has no visible emission standard it does not have to be concerned with $H_2SO_4$ formation. Finally, SLC argues that since the $SO_2$ concentration at Solnhofen is "several orders of magnitude less" than Greenport, Solnhofen has less potential to generate $SO_3$ and an acid plume.

SLC's concerns are unfounded for the following reasons. First, as stated in Section 4.3, the $SO_2$ level at Solnhofen is most likely somewhere between 400 mg/Nm$^3$ and 733 mg/Nm$^3$. Despite these levels, visible plumes have not been a problem at Solnhofen. In fact, the SCR system at Solnhofen is credited with eliminating 50% to 70% of the $SO_2$ in the exhaust gas. Haug et al. p. 4. This result is consistent with the statement by Tom Lugar of KWH that the $SO_3$ generated by the process is captured by the large amount of free lime in the system. *See* Attachment B, KWH Letter, pp. 1-2. Thus, while the visible emission standards at Greenport and Solnhofen may be different, the Solnhofen SCR experience shows that an SCR system can operate at high NOx reduction levels (greater than 80%) with significant levels of $SO_2$ in the gas stream and still not generate $SO_3$ and an acid plume. Thus, the regulatory differences between the two plants are irrelevant. In fact, the opposite may occur since SCR may reduce visible emissions since it reduces the amount of ammonia required for injection when compared to SNCR and so may reduce the likelihood and potential size of any plumes.

#### 5.2.1.3 Operational Differences

SLC states that because the Greenport project will have an exit preheater tower temperature of 610° F (which is at the low end of the normal operating range of SCR systems), the NOx control efficiency at Greenport will be reduced. According to SLC, this will be particularly true during process upsets when the preheater tower exit temperature drops below its normal operating range. SLC states that at Solnhofen "where the average NOx reduction is approximately 40%" the facility can afford periods of low NOx reduction efficiency. SLC also states that the Solnhofen plant has a four-stage preheater tower whereas the Greenport Project will have a five-stage preheater tower which will result in a lower preheater tower exit temperature, thereby increasing the risk that Greenport will not meet its NOx reduction efficiency.

These concerns do not pose obstacles to SCR use at Greenport. KWH in its letter to CDM stated that as long as a temperature of 600° F is maintained at the inlet to the SCR catalyst, a minimum NOx reduction efficiency of 85% can be guaranteed. Alstom, in its response to SLC, stated that operation of the SCR catalyst at temperatures of 570° F would be acceptable for short periods of time (2 -3 hours) but not for prolonged operation. Thus, contrary to SLC's statement, operation at 600° F (the low end of the SCR operating range) will not affect the performance of the SCR system. Furthermore, temperature fluctuations below 600°F can be handled by the use of a bypass duct around the last preheater cyclone as described in Section 4.4.2. As noted in Section 4.8A, SLC is achieving an 82% NOx reduction (not 40% as SLC claims), showing that a high NOx reduction efficiency can be maintained despite SLC's operational concerns. Lastly, the fact that Solnhofen has one less preheater cyclone than Greenport is immaterial in light of evidence that the catalyst suppliers can guarantee a high NOx reduction efficiency for the design preheater exit temperature at the Greenport plant. Thus, the operational differences identified by SLC are not obstacles to achieving a high degree of NOx reduction at the Greenport plant.

#### 5.2.1.4 Fuel Differences

Fuel differences are not likely to affect the performance of SCR systems on a cement kiln. Sulfur in SCR systems can cause detrimental effects including generation of $SO_3$, formation of and masking from $CaSO_4$, formation of $H_2SO_4$ and reaction of $SO_3$ with $NH_3$ to form ammonium salts. In the case of preheater/precalciner kilns, however, the sulfur content of the fuel used does not contribute to these problems. As pointed out by Terry of Krupp Polysius, "The sulfur content and its various compounds in the fuel have no significant impact on $SO_x$ emissions from preheater or precalciner kilns. In fact, measurements have proven that virtually no $SO_2$ exists after stage 2 (counting from the bottom of the preheater)." Terry, M.S. Undated. BACT: What is Achievable with Today's Technologies, Krupp Polysius Corp., p. 7. Thus, differences in fuel are not important in assessing the performance of SCR systems on cement kilns. Although the Greenport plant will use coal and petroleum coke for fuel while Solnhofen uses primarily oil, this difference will not hinder the ability of an SCR system at Greenport to achieve a high degree of NOx reduction.

### 5.2.1.5 Size and Production Capacity Differences

SLC states that the production capacity of the Greenport plant will be more than four times greater than the production capacity at Solnhofen and that the exhaust gas flow at Greenport will therefore be significantly greater than the flow rate at Solnhofen. SLC claims that the greater exhaust gas flow at Greenport will make it more difficult to achieve an even gas flow distribution across the SCR reactor cross section and that large deviations in flow distribution are likely to occur that will affect the SCR system's performance, particularly NOx reduction and $NH_3$ slip. Furthermore, SLC states that the flow distribution problems at the outlet of the preheater towers and the requirement to mix the exhaust gas from two preheater towers at Greenport presents unique challenges to SCR system suppliers.

The challenges claimed by SLC are not nearly as great as those already faced by SCR system suppliers at coal-fired power plants. The gas flow rates at many coal power plants are typically 5 to 20 times greater than the gas flow rate at Greenport and at many of these plants a high degree of NOx reduction (90% in some cases) is being achieved. If SCR system suppliers can resolve flow distribution problems at plants with gas flows 20 times greater than the Greenport plant, it appears that flow distribution problems should not be an obstacle to the successful use of SCR at Greenport. Both KWH and Alstom have indicated that they can design an SCR system for Greenport's gas flow rate.

#### 5.2.1.6 Catalyst Performance

Contrary to SLC's assessment of the Solnhofen experience, the Solnhofen SCR system has clearly demonstrated a good record of performance. The facility has achieved greater than 80% NOx reduction, low $NH_3$ slip (reported at less than 1 mg/Nm$^3$), and a catalyst life exceeding 24,000 hours to date. The Solnhofen SCR system has been meeting the German government's NOx emission limit of 500 mg/Nm$^3$. The SCR system is equipped with only three of a possible five layers of catalyst and thus has the provision to meet a future NOx limit of 200 mg/Nm$^3$. *See* Attachment B, KWH Letter, p. 3.

#### 5.2.1.7 Conclusion

SLC's argument that SCR has not been achieved for cement plants is premised on the notion that the Greenport cement plant and the Solnhofen cement plant are not in the same source category. The issue in this case is not, however, whether the two cement plants are in the same source category but whether the facilities are sufficiently similar in terms of processes and gas streams to allow for the successful application of the SCR technology currently in use at the Solnhofen facility at Greenport. SLC identifies various differences between the two plants which it argues preclude the application of SCR at Greenport. As discussed in Sections 5.2.1.1 through 5.2.1.6, these differences do not pose obstacles to installing and operating an SCR system. The issues identified either have no emissions implications whatsoever or can readily be addressed through proper design and operation of the system.

### 5.2.2 Achieved in Practice

In support of its argument against requiring SCR to achieve LAER, SLC argues that the LAER emission rate has not been "achieved/demonstrated in practice," i.e., that the technology used to achieve LAER has not been "installed and operated successfully" as defined by DEC/EPA. In identifying criteria for determining whether a technology has been "demonstrated in practice," SLC cites to a 1996 Federal Register notice issued as part of an earlier NSR reform proposal. In that notice, EPA proposed to define "demonstrated in practice" to include technologies that have been installed and operated continually for at least six months on a unit operating at 50 percent capacity or more that have been shown to be successful via a performance test. 61 Fed. Reg. 38,249, 38,275 (July 23, 1996). According to SLC, the Solnhofen facility does not meet these criteria and so the emission reductions at the facility cannot be said to have been "achieved in practice" for LAER purposes. SLC also goes to some length to dismiss Solnhofen as irrelevant because the facility is German rather than American. For the reasons set forth below, these arguments should be rejected.

#### 5.2.2.1 EPA Criteria [NOTE: This section does not correspond to a section in SLC's Supplemental LAER Analysis.]

As SLC correctly notes, the criteria outlined in the 1996 Federal Register notice were never adopted as regulations. Although EPA has since adopted revisions to the NSR rules, these changes focus on NSR applicability issues and do not in any way address LAER criteria. Even assuming that these unadopted criteria reflect current EPA policy, the Solnhofen plant more than satisfies them. As set forth in Attachment B, discussions between representatives of Solnhofen and KWH, their catalyst supplier, indicate that the SCR system has been operating for over 24,000 hours (almost three years) and has been maintaining compliance with the regulatory limits imposed by the German government. Moreover, the facility is achieving NOx reductions of approximately 82% percent, not 40% as claimed by SLC. Thus, contrary to SLC's assertions, the available emissions data *do* satisfy EPA's "test" for "determining whether SCR technology, as applied to cement plants, has been achieved in practice." SLC Supplemental LAER Analysis, § 5.2.2, p. 5-16.

**5.2.2.2 Relevance of Foreign Technologies/Limits** [NOTE: This section does not correspond to a section in SLC's Supplemental LAER Analysis.]

As it has in the past, SLC attempts to dismiss the experience at the Solnhofen plant on the ground that the plant is German, not American. As SLC notes, however, EPA expressly requires applicants to consider technologies successfully demonstrated outside the United States in setting BACT and LAER. *See* EPA, *NSR Workshop Manual,* pp. B.5 (requiring consideration of "technologies employed outside the United States"); B.11-B.12 (requiring consideration of "technologies in application outside the United States to the extent that the technologies have been successfully demonstrated in practice in full scale operations").[18]

Foreign technologies/limits are subject to the same basic standard as that applicable to domestic technologies – whether the technology/limitation been achieved in practice or can reasonably be expected to be achieved in practice for a category of emissions sources. Regardless of whether the source is located abroad or at home, this analysis addresses various

18 The discussion of the application of foreign technologies in the NSR Workshop Manual focuses on BACT. Given that LAER is intended to be a stricter standard than BACT, the same argument also applies to LAER determinations.

factors, including the applicable regulatory environment and accessibility to information. The only difference for foreign facilities is that these factors may be more difficult to establish. They do not, however, bar consideration of foreign sources in the determination of BACT/LAER.

In this case, SLC and CDM together have obtained extensive information about the Solnhofen plant's experience with SCR. These documents provide detailed information about operations at the Solnhofen plant both generally and in relation to its SCR system. The most useful data obtained were annual CEMS emissions reports on dust and NOx emissions for the period 1992 through 2002.

Moreover, in its February 27, 2004 response to CDM's revised Bid Specification, KWH reported that Solnhofen's plant manager would be pleased to provide more detailed SCR performance data and process exhaust gas and particulate raw feed data, provided a confidentiality agreement was in place. Although CDM does not believe that additional information is necessary to assess whether SCR and its related emission rate have been "achieved in practice" at Solnhofen, it is nevertheless willing to pursue further discussions with Solnhofen at DEC's request.

As it has in the past, SLC cites to various EPA and other decisions to support its arguments against considering "foreign" (i.e., German) technological advances in setting LAER for the SLC plant. As was true in the past, SLC's citations are at best irrelevant and at worst, misleading. For example, SLC quotes *Ogden Martin Systems of Onondaga, Inc.*, Proj. No. 7-3142-00028/000-0, 1991 WL 1178776, *9 (Dec. 11, 1991) for the proposition that "European standards are presumably based upon European laws – not the CAA. It cannot be assumed that the US EPA (or DEC) has the authority to impose the same numerical standards that European countries do." In *Ogden*, the prospective intervenors were advocating that DEC impose an emission limit of 40 micrograms per cubic meter based solely on the fact that the limit was being imposed by the Swedish government on a similar facility without explaining why that number would be BACT for the facility. *Id.* at *10. In the present case, however, no one is suggesting that DEC impose the same emission limits as are currently being imposed on the Solnhofen plant solely because German authorities have imposed them. Instead, FOH is arguing only that the successful use of SCR at the Solnhofen plant shows that the technology is feasible as applied to cement plants and that it should be considered by DEC in its ongoing assessment of LAER for the SLC project.

Similarly, SLC cites *In re Pennsauken Solid Waste Management Authority,* 238 N.J. Super. 233, 569 A.2d 826 (App. Div. 1990) to support its argument against relying on foreign plants as a basis for setting LAER. A quick review of the passage quoted by SLC indicates that the problem with the solid waste facilities being cited as the basis of LAER was not necessarily that they were foreign. The problem was that the control technology being used at the foreign plants was unreliable and thus not a suitable basis for setting LAER. *Id.* at 253, 569 A.2d at 836 ("We stress that [SCR] is not currently employed with respect to a municipal solid waste incinerator anywhere in the United States. Moreover, in its experimental utilization in Japan, SCR has apparently been deemed unreliable due to latent difficulties associated with its use.").[19]

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[19] In *In re Old Dominion Electric Cooperative*, PSD Appeal No. 91-39, 1992 WL 92372 (EAB, Jan. 29, 1992), the State of New Jersey declined to require a coal-fired power plant to install SCR after noting that actual use of SCR was limited at the time to foreign facilities, which they distinguished from the facility being permitted based on differences in coal type and boiler design. In upholding this decision, the EAB noted that while these differences were not apparently scrutinized by the State, the record did not conclusively demonstrate that the State should have required SCR in this instance. In essence, the EAB deferred to the State's decision, rather than undertaking its own LAER analysis (as is appropriate given the EAB's role in the PSD review process). A thorough reading of the decision indicates that New Jersey was motivated primarily by differences between the foreign facilities and the facility being permitted and not simply by the fact that the facilities equipped with SCR were foreign.

Similarly, in the case of *Steel Dynamics, Inc.*, PSD Appeal Nos. 99-4 and 99-5, 2000 WL 833062 (EAB June 22, 2000), the Japanese mills relied on by petitioners as a basis for their BACT claims were apparently no longer operating when the project was being reviewed. In both of these cases, the decision not to consider foreign facilities in setting LAER was based on particular inadequacies with those facilities (poor operating history, lack of data) and not on the fact that the facilities were foreign. In the current situation, by comparison, the Solnhofen cement plant has been using SCR successfully for almost three years and has accrued extensive data concerning its operations. This experience must be considered by DEC in assessing LAER.

#### 5.2.2.3 Conclusion

For the foregoing reasons, DEC must reject SLC's argument that the emission reductions occurring at the Solnhofen facility using SCR have not been "achieved in practice" for purposes of LAER. The Solnhofen facility has been achieving emission reductions of approximately 82% for almost three years using SCR. This success is documented in data accumulated by SLC, CDM and others concerning facility operations. This information is more than sufficient to show that the emission reductions have been "achieved in practice" and are therefore LAER.

### 5.3 Test Two: "Reasonably Expected to Occur in Practice"

In further support of its argument against requiring SCR to achieve LAER, SLC argues that the LAER emission rate cannot "reasonably be expected to be achieved in practice." As articulated by SLC, this analysis requires an assessment of whether a particular technology is "available" (i.e., can be obtained by the applicant through commercial channels or is otherwise available) and "applicable" (i.e., can be installed and reasonably expected to operate on the source under consideration). SLC Supplemental LAER Analysis, § 5.3, pp. 5-18 to -22. SLC then points to the purportedly inadequate bid responses and to technological differences between the Greenport plant and existing projects equipped with SCR as evidence that the Greenport plant does not meet these criteria.[20]

Once again, however, SLC has adopted a cramped interpretation of LAER that virtually assures the rejection of SCR as a basis for achieving LAER. In New York, a permitting authority may subject a source to emission limits comparable to those actually being "achieved in practice" by other sources in the same source category to satisfy LAER. Permitting authorities also may impose the most stringent limits that "can reasonably be expected to be achieved in practice" for a category of emission sources. LAER has been interpreted by EPA and DEC to require consideration of "technology transfer" – the application of technologies used in one industry to other industries with similar processes or gas streams. If it can be shown that a particular technology can be transferred from one industry to another and will achieve a lower emission rate than other, more "conventional" technologies, facilities will be required to install the new technology to achieve LAER.

### 5.3.1 Availability

SLC cites the NSR Workshop Manual for guidance on when a technology is considered "available." According to the Manual, a technology is "available" if it can be obtained by the

20 In an attempt to boost its arguments against SCR, SLC suggests that DEC should not "experiment" with control technologies in light of the "important role cement plays in New York's construction industry," and cites electric power as an example. SLC's attempt to analogize cement manufacturing and electric power generating must be rejected. Electric power generating is a crucial component of our economy as the August 2003 blackout illustrated; society essentially grinds to a halt without power. Limits on our ability to transfer power from state-to-state and concerns about relying too heavily on out-of-state power sources make a safe, dependable source of in-state electricity crucial. This importance of electric power to the economy no doubt may influence the willingness of regulators to "experiment" with control technologies at power plants. Cement by comparison is simply a

applicant through normal channels or is otherwise available within the common sense meaning of the term.[21] NSR Workshop Manual, p. B.18. Vendor guarantees, according to SLC, are one indication of commercial availability. As EPA notes, however, vendor guarantees are relevant to assessing both "availability" and "applicability" as those terms are used by SLC. According to the NSR Workshop Manual,

> Vendor guarantees may provide an indication of commercial availability and the technical feasibility of a control technique and could contribute to a determination of technical feasibility or technical infeasibility, depending on circumstances. However, EPA does not consider a vendor guarantee alone to be sufficient justification that a control option will work. Conversely, lack of a vendor guarantee by itself does not present sufficient justification that a control option or an emission limit is technically infeasible. Generally, decisions about technical feasibility will be based on chemical and engineering analyses . . . in conjunction with information about vendor guarantees. Id. at B.20.

In this case, SLC submitted a request for proposal to various SCR vendors and did not receive back any bids that it deemed satisfactory. According to SLC, this result shows that SCR is not "available" for the Greenport project. As discussed in Section 4.10 above, however, SLC's approach to the bidding process virtually ensured this result. The Bid Specification, including the performance guarantees and penalty provisions, was unreasonably strict, both with respect to the needs of the project and when compared with the bid specifications for other projects. The strictness made meeting the Bid Specification impossible. Moreover, the bid process was designed to discourage bidders from raising questions about the Bid Specification

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commodity. If the Greenport plant is not constructed, cement can be obtained from other in-state or out-of-state sources.

21 Arguably, SLC's focus on availability is somewhat misplaced. Availability is a concept more relevant to BACT than LAER, which focuses on achievability rather than availability. As a practical matter, however, if no one is willing to install control technologies that will achieve the "lowest achievable emission rate" the rate arguably is not achievable.

and working with SLC to develop an acceptable proposal. SLC would likely have received a more positive response to its RFP if its selection criteria and process had been more reasonable. In fact, CDM received a response from a vendor (KWH) indicating that it could supply SCR equipment that would satisfy the more reasonable criteria in CDM's revised Bid Specification. These facts show that SCR (and the emission reductions achievable using SCR) are "available" for purposes of NSR if SLC is truly interested in pursuing SCR.

### 5.3.2 "Applicability" Test

According to SLC, an available technology is "applicable" if it can be installed and reasonably be expected to operate on the source under consideration. SCR Supplemental LAER Analysis, § 5.3.2, pp. 5-22 (citing NSR Workshop Manual, at B.17). Despite all of SLC's rhetoric, the so-called "applicability test" is nothing more than an assessment of technological feasibility. In making this assessment, EPA and DEC require applicants to look not only at sources in their own source category, but at whether technologies can be transferred between source categories. As articulated by EPA, there are two types of potentially transferable control technologies: gas stream controls and process controls and modifications. According to EPA, for gas stream controls:

> We consider the class or category of sources to include any sources that produce similar gas streams that could be controlled by the same or similar technology. The process that generates a volatile organic compound (VOC) laden gas stream, for example, is immaterial. What matters is whether the gas stream characteristics, such as composition and VOC concentration, are sufficiently similar to a stream from which incineration technology, for example, may be transferred. The same would be true for the control of particulate matter or sulfur dioxide in a gas stream using control devices such as baghouses or scrubbers.

For process controls, by comparison,

> Process similarity governs the decision. For example, coating compositions and application of technology probably do not vary substantially across the entire class of motor vehicle coating sources. A source within that category would, therefore, have to clearly demonstrate the unique process characteristics that preclude it from using otherwise transferable LAER technology used by a similar but not identical source. We would be more cautious, however, before grouping more disparate operations, such as coating semiconductor circuit boards, in the same class as coating motor vehicles.

EPA Technology Transfer Memo, pp. 1-2. In essence, EPA expects sources to transfer technologies to achieve LAER if it appears that the gas streams and/or processes are similar enough that the transferred technology can reasonably be expected to work.

As articulated by EPA, whether a technology is feasible requires technical judgment to determine whether a particular control technology applies to the source under consideration. In the case of add-on controls,

> decisions of this type would be made by comparing the physical and chemical characteristics of the exhaust gas stream from the unit under review to those of the unit from which the technology is to be transferred. Unless significant differences between source types exist that are pertinent to the successful operation of the control device, the control option is presumed to be technically feasible unless the source can present information to the contrary. NSR Workshop Manual, at B.19.

If necessary, EPA may require physical modifications to a facility to accommodate pollution controls. *Id.* ("Physical modifications needed to resolve technical obstacles do not in and of themselves provide a justification for eliminating the control technique on the basis of technical infeasibility.")

Ensuring appropriate technology transfers is crucial to successfully implementing NSR. As noted at the outset, applicants required to meet LAER are asking permission to install or modify a source that will increase emissions of contaminants for which an area already is in nonattainment. Requiring NSR sources to consider technologies beyond those used by others in their source category protects the ambient air quality in areas with existing air pollution problems by ensuring that new and modified sources emit nonattainment contaminants at the lowest achievable rate.

SLC's heated rhetoric aside, the current debate is nothing more than a disagreement about whether SCR can be installed at the Greenport plant and achieve emission reductions greater than those likely to be achieved through a combination of MSC and SNCR. SLC's argument, as it has been throughout the permitting process, is that Greenport is "different" – technologies that have been proven elsewhere will not work at Greenport because Greenport is bigger, uses different inputs, will emit different pollutants, uses different processes, etc. FOH and its consultants believe that SLC is overstating these differences and/or that these differences can be readily addressed through minor process or equipment changes.[22] This debate is summarized below.

### 5.3.3 Application of Technical Facts on Technology Transfer

#### 5.3.3.1 Coal-Fired Boiler to Cement Plant

As SLC correctly notes, SCR has been installed and successfully operated on dozens of large coal-fired utility boilers. However, SLC argues that differences between these boilers and the Greenport plant (relating to $SO_2$ and calcium loading, particulate loading and dust

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22 In support of its argument SLC cites two horror stories – the American Electric Power (AEP) plant in Gavin, Ohio, and the Puerto Rican Electric Power Facility in Puerto Rico – as evidence of the dangers of inappropriate technology transfer. In both cases, SCR was installed at power generating facilities with purportedly disastrous results. The lessons from these examples cannot, however, be judged without complete information about the projects. Moreover, SLC neglects to discuss the dozens of power generating facilities that have successfully installed and operated SCR to reduce NOx.

characteristics, and alkali compounds) "make the transfer of SCR to a cement kiln exhaust stream technically inappropriate". SLC Supplemental LAER Analysis, § 5.3.3.1(d), p. 5-28. Contrary to SLC's assertions, these purported differences do *not* pose insurmountable obstacles to the application of SCR.

### 5.3.3.1(a) $SO_2$ and Calcium Loading

According to SLC, the high concentrations of calcium in the Greenport raw feed (relative to coal-fired boilers), combined with high levels of $SO_3$ are likely to result in the formation of $CaSO_4$ within the catalyst pore structure, leading to pore plugging and masking. In fact, however, SCR has been successfully operated at coal-fired plants that burn coal with a high calcium content. As indicated in the table at Attachment C, the Kansas City Power & Light facility burns PRB coal with an average calcium oxide content of 7.4 grams/Nm$^3$ and an $SO_2$ concentration of 420 ppmv. Although these levels are less than the expected calcium oxide and $SO_2$ levels at Greenport (26 grams/Nm$^3$ of CaO and 600 ppmv of $SO_2$), the levels of calcium and $SO_2$ at Kansas City Power & Light are sufficiently high to demonstrate that the potential problems of $SO_2$ oxidation and masking from $CaSO_4$ have been addressed and resolved at this plant.

More important, a more thorough estimation of $SO_2$ levels throughout the Solnhofen plant shows that the $SO_2$ concentration at the inlet to the SCR system could be in the range of 400 mg/Nm$^3$ to 733 mg/Nm$^3$. Thus, the Solnhofen SCR system has been subjected to high $SO_2$ levels and high calcium levels and there have been no $CaSO_4$ masking, poisoning, or plugging problems from ammonium salts and no sulfuric acid plume formation according to the plant manager.

### 5.3.3.1(b) Particulate Loading and Dust Characteristics

Problems of surface plugging and erosion caused by particulate loading have largely been solved at coal-fired power plants equipped with SCR. SLC contends, however, that "there are many reasons to believe that these successes will not readily transfer to cement kilns like the Greenport Project." SLC Supplemental LAER Analysis, § 5.3.3.1(b), p. 5-26. Among other things, SLC argues that the particulate loading at the inlet to an SCR system at Greenport would be up to 20 times higher than the loading to at a coal-fired utility boiler. As discussed in Section 4.2.2.2, however, the Solnhofen SCR system has operated at a dust loading of 80 g/Nm$^3$, 20 grams *higher* than the dust loading anticipated at Greenport. This experience suggests that differences in particulate loadings between coal-fired boilers and Greenport should not bar technology transfer.

SLC also suggests that the particles at Greenport are likely to be smaller than those at coal-fired boilers and may result in the formation of sticky deposits that could foul the SCR catalyst. The most convincing evidence refuting these possibilities is the operating experience at Solnhofen. The initially installed catalyst at Solnhofen has been in operation for over 24,000 hours and has not become plugged or fouled from fine or sticky particles. The catalyst soot blowing and cleaning systems have maintained the catalyst in good operating condition as evidenced by the fact that the SCR system has continued to meet the applicable NOx regulatory standard of 500 mg/Nm$^3$. Based on the average inlet NOx loading of 2500 mg/Nm$^3$, this corresponds to greater than 80% NOx reduction. Attachment B, KWH letter, p. 3.

### 5.3.3.1(c) Alkali Compounds

SLC argues that the concentrations of catalyst poisons are higher and that these poisons are more available in a cement kiln than they would be in a coal-fired boiler. As discussed in Section 4.2.2.1, coal-fired boilers have alkali in their flue gas at concentrations which are, in some cases, greater than those expected at the Greenport plant. Furthermore, some of the flyash from coal-fired boilers is water soluble; thus, the alkali in the flyash would theoretically be available to deactivate an SCR catalyst. However, catalyst deactivation has not been a problem at coal-fired boilers. Moreover, in the case of oil-fired boilers, the majority of the alkaline metals in the flyash are water-soluble. Pritchard et al. Optimizing SCR Catalyst Design, p. 10, which, according to SLC, would render these plants unsuitable for an SCR catalyst. However, the SCR suppliers have numerous SCR systems installed on oil-fired boilers. Thus, SCR systems have been successfully used on both coal-fired and oil-fired boilers despite the presence of water soluble, alkaline metals in the flyash. Thus, the presence of alkaline compounds should not pose an insurmountable obstacle to applying SCR to the Greenport project.

#### 5.3.3.1(d) Conclusion on Technology Transfer From Coal-Fired Utility Boilers to Cement Kilns

None of the "differences" identified by SLC between coal-fired boilers and cement kilns preclude technology transfer of SCR technology. Many of the problems identified by SLC already have been addressed by SCR developers, as evidenced by the successful operation of SCR on coal and oil-fired boilers operating under a wide range of conditions. Moreover, the experience at Solnhofen shows that the differences between coal-fired boilers and cement kilns do not pose an obstacle to successful implementation of SCR.

### 5.3.3.2 Technology Transfer: Solnhofen to Greenport

In this section, SLC argues that differences between Solnhofen and Greenport prevent technology transfer. At its core, however, this section is merely a rehashing of SLC's argument in Section 5.2.1 that the Greenport facility and Solnhofen are not in the same "source category." In both cases, SLC is arguing that Solnhofen and Greenport are "different" and that these differences preclude the application of SCR.[23] This argument should be rejected for the reasons set forth below.

**5.3.3.2(a) Catalyst Masking**

SLC contends that the $SO_2$ concentrations at Greenport are expected to be as much as 300 times the concentration at Solnhofen, raising the potential for pore plugging or masking of the catalyst, formation of visible plumes, and the formation of other corrosive compounds. As presented in Section 4.3, a review of the $SO_2$ data for the Solnhofen plant strongly suggests that the $SO_2$ concentration at the inlet to the SCR reactor is considerably higher than the 6 mg/Nm$^3$ concentration cited by SLC. The 6 mg/Nm$^3$ concentration is a stack concentration. Making reasonable estimates of the $SO_2$ reduction which takes place between the reactor inlet and the stack, reveals that the $SO_2$ concentration at the catalyst inlet could be as high as 400 mg/Nm$^3$ to 733 mg/Nm$^3$.

In any case, it is noteworthy that the catalyst suppliers are not particularly concerned about the high $SO_2$ concentration and potential for high $SO_2$ oxidation. Note that KWH, in its response to CDM's Bid Specification, states that its proposed SCR system for the Greenport project could meet the following performance guarantees: a minimum 85% NOx reduction

23 In support of this argument, SLC cites the response to its RFP received from KWH, Solnhofen's catalyst supplier, stating that Solnhofen could not be used as a benchmark to extrapolate the SCR catalyst designs for the Greenport Project. Presented with a more reasonable bid specification prepared by CDM, KWH addressed many of the obstacles to installation of SCR raised by SLC.

(provided the catalyst inlet temperature is maintained at a minimum of $600^0F$), an ammonia slip of 2 ppmv or less, and a catalyst life of 16,000 or perhaps 24,000 hours (depending on the results of bench reactor catalyst tests currently being performed on the Solnhofen catalyst). Note that KWH made its guarantees even though the plant data sheets (contained in CDM's Specification) clearly show that the $SO_2$ concentration in the preheater exhaust would be 600 ppmv (1700 $mg/Nm^3$) to a maximum of 750 ppm (2125 $mg/Nm^3$). When CDM questioned KWH about this issue, KWH's response was that the $SO_2$ and $SO_3$ will not have a significant impact, since any $SO_3$ formed would be captured by the large amount of lime in the process. Attachment B, KWH Letter, pp. 1-2.

Similarly, Alstom in its initial Proposal to SLC dated September 19, 2003 makes the following performance guarantees: 90% NOx reduction for the life of the catalyst, 2 ppmv ammonia slip, and a catalyst life of 24,000 hours. Again, these guarantees are made even though the SLC Bid Specification clearly states that $SO_2$ concentration in the preheater exhaust would be 600 ppmv to 750 ppmv. Also, Alstom in its letter to SLC dated October 20, 2003 stated that they were prepared to provide a 0.5% guarantee on $SO_2$ oxidation. This level is quite different from the 70% $SO_2$ oxidation rate included in SLC's Supplemental LAER Analysis. This information shows that the potential problems related to $SO_2$ oxidation (pore plugging and masking, plugging from ammonium salts) are not significant concerns to the SCR catalyst suppliers; as a result, they should not be used as reasons for claiming that SCR is technically infeasible for the Greenport plant.

**5.3.3.2(b) Visible Emissions**

As further support for its argument against considering the Solnhofen experience in assessing the technical feasibility of installing SCR at Greenport, SLC notes that Solnhofen is not expected to limit visible emissions and that the conditions necessary to create visible emissions are more likely to occur at Greenport than Solnhofen. SLC cites two possible causes for a visible plume: one from $SO_3$ reacting with water to form $H_2SO_4$ and the other from $SO_3$ reacting with $NH_3$ to form ammonium sulfate (AS) or ammonium bisulfate (ABS). SLC argues that due to the higher concentration of $SO_2$ in the preheater exhaust anticipated at Greenport, more $SO_3$ will be generated and, hence, there will be greater potential to develop a visible plume. SLC also reiterates its argument concerning the great short-term variation in uncontrolled NOx concentrations at cement plants which will cause difficulty in achieving the proper ratio of NOx to $NH_3$ and result in high levels of $NH_3$ slip.

These arguments should be rejected. As previously noted, a review of the $SO_2$ levels at Solnhofen suggests that the difference in $SO_2$ levels at the reactor inlet at Greenport and Solnhofen is not as great as SLC indicates. Regarding the impact of sulfur compounds, the catalyst suppliers (KWH and Alstom) do not believe that $SO_2$ oxidation and $SO_3$ are major concerns. Alstom is willing to guarantee a 0.5% $SO_2$ oxidation rate as opposed to SLC's assumed 2% $SO_2$ oxidation rate. KWH states that any $SO_3$ generated in the process will be captured by the large amount of free lime as CaO in the gas stream.

Regarding $NH_3$ slip, the article by Haug et al. on the Solnhofen plant states that the $NH_3$ slip is very low, less than 1 mg/Nm$^3$ (1.3 ppmv). Haug, p. 4. Contrary to SLC's assertions, it is possible to operate an SCR system on a cement plant with highly fluctuating NOx concentrations and achieve low $NH_3$ slip. In addition, both KWH and Alstom are willing to guarantee a 2 ppmv $NH_3$ slip for the Greenport plant. Thus, there will not be much unreacted $NH_3$ available to form ammonium sulfate. Also, AS and ABS form at temperatures below about 570° F. Since the design temperature at the reactor inlet at Greenport is 610° F, AS and ABS will only be formed during plant upset conditions. As previously discussed, low temperature conditions can be prevented by installing a bypass duct around the last preheater cyclone tower. A reactor bypass duct also would be installed to protect against high temperature conditions. SCR systems on coal-fired power plants typically have both types of bypasses.

Thus, the catalyst suppliers responses, the low $NH_3$ slip at Solnhofen, the low $NH_3$ slip guarantees from KWH and Alstom, and the existence of readily available means to control the SCR inlet temperature, support the conclusion that the possibility of visible plume emissions is extremely low and should not be used as a reason for dismissing SCR at Greenport.

#### 5.3.3.2(c) Catalyst Fouling

SLC hypothesizes that the gas stream characteristics "raise a real concern" that the facility will be faced with the accumulation of sticky dust on the preheater fan and in the flow straighteners, a problem not experienced at Solnhofen. However, SLC offers no real support for this hypothesis beyond general statements of concern about "this important and significant unknown." SLC Supplemental SCR Analysis, § 5.3.3.2(c), p. 5-31.

As discussed in Section 4.2.2.2, this problem appears to mainly affect kiln I.D. fans. According to the article cited by SLC, the problem is temperature and impact velocity-related and is most readily solved by selecting a larger and slower RPM fan. The problem is further discussed in the European Commission document entitled *Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the Cement and Lime*

*Manufacturing Industries*, European IPPC Bureau, Seville, Spain, March 2000, p. 14, which states the following:

> Severe problems have in the past been encountered with four stage preheaters in cases where inputs of circulating elements (chlorides, sulfur, alkalis) from the feed and/or fuel were excessive. Highly enriched cycles of these elements lead to build-ups in cyclone and duct walls, which frequently cause blockages and kiln stops lasting several days.

The document further states,

> Kiln gas bypass, i.e. extraction of part of the particulate laden gas stream leaving the kiln so that it bypasses the cyclone system, is a frequently used solution to the problem.

Thus, the "sticky deposit" problem will be solved by the alkali sulfur reduction system (ASRS) which is proposed for the Greenport plant and will make it possible to operate an SCR system without the possibility of "sticky deposits".

**5.3.3.2(d) Catalyst Poisoning**

Finally, SLC hypothesizes that because the Solnhofen facility does not operate an alkali bypass, the concentrations of certain catalyst poisons (e.g., arsenic, sodium and potassium) in the gas stream may be lower at Solnhofen than at Greenport and the alkali particles may be more "available" to poison the catalyst. As set forth in Section 4.2.2.1, SLC's concerns regarding catalyst poisoning lack a sound factual basis.

As noted in Section 5.3.3.2(c), one of the main reasons for an alkali bypass is to reduce the concentrations of sulfur and alkali in the preheater cyclones to prevent plugging and blockages. Since as much as 30% of the kiln exhaust will be sent to the alkali bypass at Greenport, the concentrations of sulfur and alkali at the preheater outlet at Greenport may be less than the levels at Solnhofen. In any case, the alkali bypass at Greenport will significantly reduce the levels of sulfur and alkali that the catalyst would be exposed to and thus will greatly benefit an SCR system at Greenport.

As previously discussed, SCR systems on coal-fired power plants have, in some cases, greater arsenic, sulfur and alkali levels than are those anticipated at Greenport and yet these systems have operated successfully. In addition, several SCR systems have been installed on oil-fired power plants where a majority of the alkali in the ash is water-soluble and hence available to the catalyst. It is noted that none of the catalyst suppliers who responded to SLC or CDM cited catalyst poisoning as a potential problem for the Greenport project. Based on the above it does not appear that catalyst poisoning will be a problem at the Greenport plant.

#### 5.3.3.3 Conclusion on Reasonably Expected to be Achieved in Practice Test

Under nonattainment NSR, a source is expected to meet the lowest emission rate reasonably expected to be achieved in practice. This standard requires applicants to consider both technologies already being implemented on facilities in their source category as well as the possibility of technology transfer. Despite SLC's vigorous arguments to the contrary, the history of SCR with respect to both cement kilns and coal-fired power plants demonstrates that SCR can feasibly be installed at the Greenport plant to control NOx. Accordingly, this technology must be considered in setting LAER.

### 5.4 SCR as NOx LAER - Regulatory Conclusion

FOH's response to SLC's Supplemental LAER Analysis strictly follows that analysis down to the section and subsection to facilitate DEC review and comparison of the two documents. This organizational approach, while useful for comparison purposes, forces FOH to analyze LAER using the scheme articulated by SLC. Under that scheme, SLC looks at each phrase in the definition of LAER separately and then offers elaborate explanations as to why the application of SCR at Greenport does not fit within the particular phrase under review. This cramped approach makes it easy to lose sight of the purpose of LAER within the nonattainment NSR program.

Facilities subject to nonattainment NSR are asking permission to construct a major air emissions source in an area that already is experiencing serious air quality problems. Nonattainment NSR sources are required to satisfy LAER to ensure that they do not make an already bad air quality situation even worse. The LAER standard achieves this important goal in two ways:

1. LAER is the "most stringent emission rate achieved in practice or reasonably expected to occur in practice." Sources required to satisfy LAER must consider not only the emission reductions being achieved within their industry but must look at whether technologies can be transferred from other industries to control emissions. By focusing not just on what has been achieved but on what reasonably can be expected to be achieved, the LAER standard requires sources to carefully examine whether technologies successfully used at other facilities can be applied to their own operations to achieve the greatest possible emission reductions.

2. LAER is not established until the permit is issued. Sources seeking nonattainment NSR permits are therefore obligated to continually review air pollution controls throughout the permitting process. This requirement ensures that the newest most effective technologies are considered as part of the nonattainment NSR process.

In its LAER discussion, SLC goes to some length to argue that the Greenport cement plant and the Solnhofen cement plant are not in the same category and that the experience at Solnhofen is, therefore, not directly relevant in assessing LAER. However, the key to LAER is not whether the two cement plants are in the same source category. As EPA's Technology Transfer Memo makes clear, the issue in setting LAER is whether the gas streams and/or processes are sufficiently similar that emission control strategies used at one facility can reasonably be expected to work at another to achieve the maximum possible emission reductions. If the answer to this inquiry is yes, the facility will be expected to implement those control strategies, regardless of cost. Ultimately, therefore, determining LAER is a matter of assessing technical feasibility.

In this case, SLC has gone to great lengths to argue that various technical obstacles prevent the successful installation of SCR at Greenport. In so doing, SLC works hard to distinguish the Greenport plant both from the Solnhofen cement plant and from the dozens of coal and oil-fired boilers that are successfully operating SCR systems. Ultimately, however, none of the technical obstacles raised by SLC represent a bar to the use of SCR at Greenport. As discussed in Sections 4.0 and 5.0, the issues raised by SCR either are not issues at all or can readily be addressed by proper design and operation of the kiln and the SCR system. To ensure that the Greenport plant meets its LAER obligations, DEC must set emission limits based on SCR rather than MSC and SNCR, as currently proposed.

## 6.0 List of Preparers

These comments have been prepared by the following firms and individuals.

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